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EDITORIAL.

STEAM TRACTION AND THE SUPPLY OF SOLID FUELS.

WHEN the Coal Controller inaugurated his transport reorganisation scheme last winter, it was honestly believed that a great deal of hardship would have to be suffered by steam traction vehicle owners, and for that matter also by large numbers of owners of steam plant of various descriptions. The object of the scheme, as is well known, was to secure a minimum amount of traffic in the distribution of coal, and for that purpose it was laid down that consumers would have to rely as far as possible upon solid fuels produced or raised in their own districts. The country was, in fact, divided into well-defined areas for the purposes of the scheme. One consequence of this was that consumers in the North of England who had been in the habit of using the best Welsh steam coal had to make use of Yorkshire or other immediately available alternative. There was a good deal of grumbling as well as a crop of police prosecutions for excessive smoke emission, and, we understand, the Coal Controller was inundated with complaints, particularly from the North. His advisers, however, adhered to their programme, holding that there need be no trouble in using any of the available grades of coal, and in order to satisfy themselves, they instituted a series of tests with a well-known type of steam wagon, but unfortunately, not one that could be described as being in widespread use, such as is the case with the over-type wagon.

The results of these tests have been made available, and although the trials were by no means complete, nevertheless the main figures are interesting and from them we abstract the following:—

Name of Fuel.	Total Time under Steam.	Total Weight of Fuel Used.	Total Consumption per Ton-Mile in lbs.	Calorific Value.	Water Evaporated per lb. of Fuel.
	hr. min.	Lb.			
Cwmaman, Welsh ..	9 30	435	3·85	14468	6·46
Dinnington Main (Hards), Yorks. ..	6 30	360	4·775	13248	5·365
Dalton Main (Hards), Yorks. ..	4 26	295	3·915	13709	5·59
Denaby Main (Hards), Yorks. ..	5 8	345	4·575	12595	5·89
Brodsworth Main (Hards), Yorks. ..	4 49	315	4·18	12800	5·585
Houghton Main (Hards), Yorks. ..	5 12	285	3·78	13261	6·05
Manton, Notts.	5 39	315	4·18	12262	6·22
Askern Main (Hards), Yorks. ..	5 38	309	4·1	12640	5·91
Coke (starting on Coal) from Somerset Coal.........	5 53	373	4·95	8663	4·975
Selected Coke (starting on Coal) from Somerset Coal ...	6 10	409	5·43	10079	4·84
Briquettes, Quality Coal Co.'s (started up on mixture of Coal and Coke) ..	4 10	285	3·78	13508	6·21

The same vehicle was used with each fuel, the firebars were in no wise altered, that is to say, the vehicle was employed just as it was supplied for running on the best Welsh coal. Bearing in mind, therefore, that these tests cannot possibly be regarded as conclusive, since no attempt was made to make them exhaustive or comprehensive, they are, nevertheless, useful in that they show how groundless is the feeling that it is necessary to have a particular kind of coal to get good results. Here we have it shown that a steam wagon sent out to run on

the best coal will give much the same results, if we disregard the question of smoke, with a wide range of fuels of a lower calorific value. So far as it goes, therefore, we feel that the Coal Controller's Department has justified its scheme, but it is news of the utmost importance to learn that its institution has saved the country in transport the colossal figure of over 700 million ton-miles during the period it has been in operation. What justification is there, says the Controller, in short, for a man in Aberdeen insisting on having coal raised in South Wales transported all the way by rail for his benefit when he can get precisely the same results with a coal raised nearer his own door?

It will be seen from the foregoing table that the poorest results were obtained with coke, but it may not be generally known that the coke in question was produced from Somerset coal, which is notoriously unfit for the production of a decent coke. To give coke a showing, this grade ought not to have been selected, for, as has been pointed out by Mr. E. W. Nicol, engineer and fuel expert to the London Coke Committee, it is dirty and most unsuitable for gas or coke making, inasmuch as it contains 23 per cent to 28 per cent ash. It is explained that the lower figure of 8663 British Thermal Units is due to moisture absorbed through exposure to rain, etc., the coke having been in stock some time before the trials were undertaken.

In the future there is every likelihood of the movement in favour of using coke for steam generation gaining considerable proportions, and it is as well that every effort should be made to educate power users, whether in matters of traction or otherwise, that by adapting existing combustion chambers it can be used with success. Nowadays, steam wagons are usually equipped with narrow-spaced firebars and blast nozzles designed for use with friable Welsh coal, and are, therefore, obviously unsuitable for coke, which is about double the bulk of the former. Being double the bulk, of course, it is necessary, in order to burn an equivalent quantity in a given time to maintain a coke fire about twice the depth usual for coal. To force the air necessary through such a relatively deep fuel-bed, wide-spaced fire-bars and increased draught pressure have to be made use of. We must bear in mind that by using coke, not only are we using a locally available fuel which has no heavy transport charges to bear, and is therefore cheap, but we are getting an efficiency—given the proper conditions—which compares most favourably with the best coal.

Trade Items, Notes, &c.

Messrs. John I. Thornycroft and Co. Ltd., shipbuilders and engineers, have notified us that in consequence of the Government having commandeered their offices at Caxton House, Westminster, they are removing to new offices at 10, Grosvenor Place, London, S.W.1. The new offices are quite close to Hyde Park Corner Station (Piccadilly Tube) and a few minutes' walk from

Coal in Queensland.—The Ipswich deposits, 25 miles from Brisbane, occupy 12,000 square miles, and the greater proportion of them are worked in this field, but the most important are the palæozoic coalfield in the Burram, 15 miles north of Maryborough. The quantity of coal won from the State during 1915 was 1,024,273 tons, valued at £409,342. Further deposits are expected to be developed, according to the *Engineer*.

Coal Outturn.—The annual report of the Acting Chief Inspector of Mines shows that while there were only 2,814 mines at work in Great Britain and Ireland in 1917, against 2,847 in the preceding year, the number of persons employed in and about the mines under the Coal Mines Act increased from 998,063 to 1,021,340. Of these 811,510 worked underground. In and about the mines, under the Metalliferous Mines Act, 12,476 persons were employed underground in 1917, and 8,024 above ground, a total of 20,500, compared with 19,455 in the previous year. The number of mines at work decreased from 468 to 452. In and about the quarries 43,631 persons were employed in 1917, against 48,196 in 1916. The output of minerals during the year was 295,401,139½ tons, coal accounting for 248,499,240 tons of the total and iron ore for 14,845,734 tons.

The Maintenance of Electric Locomotives.—Trains of 75 ore-laden cars, each averaging at least 68 tons, are not uncommon on the Butte, Anaconda and Pacific Railway, and there are now 262,400 volt direct-current locomotives in use—those of the freight type weigh 82 tons each—as well as three tractor trucks of about half this weight. The electrical maintenance of all the locomotives and the tractor trucks is undertaken by two electricians and an assistant, who do all the rewinding of armatures and field coils, besides attending to the car heating and lighting equipment, a feat that would hardly be possible on a steam system with so very few men. The passenger locomotives are inspected electrically and mechanically every 30 to 40 days. In actual practice not more than one hour per unit is required from each electrician at the period of inspection.

Railway Material for Australia.—Experiments conducted by a special investigational committee, appointed by the Chief Railway Commissioner in New South Wales shortly after the outbreak of war, with a view to discovering a method of producing locally-manufactured accessories necessary for the construction of railway rolling-stock, have met with almost entire success, says the *Melbourne Age*. The discoveries of the committee comprise a locomotive superheater equal to any that has hitherto been produced in any part of the world; steel railway axles superior to Krupp's; steel railway tyres which have demonstrated by actual test satisfactory life; a new type of Australian boiler plate; the utilisation of a substitute for tin; and the invention of a method of building up worn tramway rails and crossings, so as to make them again useful, not once, but several times.

The Erith-Riley Automatic Stokers.—For the latest extension of their electricity works, involving boilers with furnaces 15½ ft. wide as before, the Corporation of Hull have placed with Erith's Engineering Co. an order, their fourth, for these stokers. This order is for the high-duty pattern, with one-third greater capacity than the previous ones, and suited for a normal duty of three tons an hour. As a recent sample of the coal allocated to the Corporation contained 30 per cent of incombustible ash, as compared with 8 to 10 per cent in their pre-war coal, the continuous-cleaning feature of the stoker will be called upon to deal with nearly a ton of ash an hour. Erith-Riley stokers, with a normal duty of three tons an hour, are also being delivered to the Bow power-house of the Charing Cross Co. This information is extracted from the *Times Engineering Supplement*.

First Launch at Barrow Concrete Shipyard.—The launch which took place at Barrow-in-Furness was that of the first 1,000-ton barge completed by the Ferro-Concrete Ship Construction Co. Ltd. In this yard numerous concrete ships of different types are being built on the Mouchel-Hennebique system, including sea-going barges and steam-tugs to the design and specification of the Controller-General of Merchant Shipbuilding, and cargo steamships for private ownership. Before the launch the various Government representatives and others professionally interested had an opportunity of visiting the slipways and of inspecting the three classes of vessels in different stages of construction. The launching ceremony was performed by Mr. S. F. Staples, M.Inst.C.E., representing the Controller-General of Merchant Shipbuilding, in the presence of Mr. T. G. Owens Thurston, of Messrs. Vickers Ltd.; Mr. Leopold Walford and Mr. Charles Sale, directors of the company; Mr. Scott, of Lloyd's Registry; Mr. F. Soulier-Valbert, of the Agence Havas; Mr. T. J. Gueritte, M.Soc.C.E. (France), and others. The launch went off without a hitch of any kind, and during the subsequent proceedings Mr. Staples referred to the fine spirit actuating the many firms engaged in the construction of concrete ships for the national benefit, and expressed his belief that the new branch of the shipbuilding industry would continue to be very successful after the war.

THE PRINCIPLE AND OPERATION OF THE STEAM LOOP.

By F. R. Parsons.

One is frequently led to wonder why so few opportunities are taken of automatically returning condensed steam under pressure to the boiler, after it has been used for heating purposes, etc., and thus effect what must be considerable economy in a steam installation of whatever size. Can it be that the principle and operation of the steam loop are so little understood, its advantages not realised?

It should be understood that when steam is used for heating purposes, passed through traps, separators, drying stoves, jacketed and coil-heated pans, or for any similar service, not only is the condensation water invariably wasted, but its heat is as a rule irrecoverable. Look what it would mean in the saving of fuel if all the discharge from these vessels, possessing perhaps a temperature of from 300 to 400 degrees Fahr., higher generally in temperature that the feed from an economiser, can be returned to the boiler automatically, without labour, and without cost.

The Principle of Application.

We will very briefly review the principle and application of both the gravity system of returning condensed steam to a boiler, as also the steam loop,

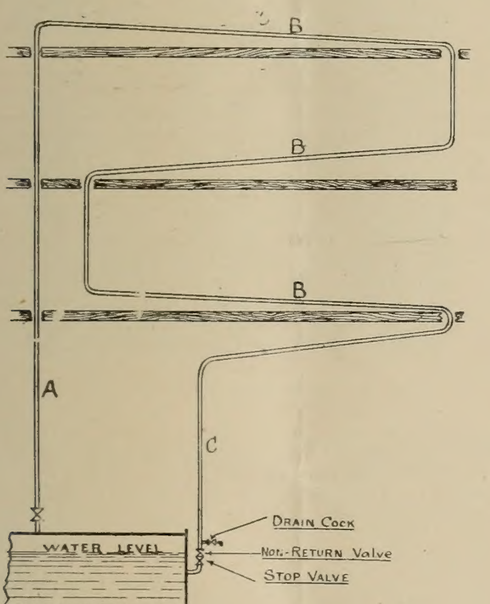

Fig. 1.

which is a development of the simple gravity system, in the hope that it will interest some of the readers of this journal. The gravity system depends for its proper working upon the weight of a column of water contained in a vertical pipe overcoming the pressure or weight of water contained in the boiler. Let us, however, make this clear by means of a graphical illustration.

In Fig. 1 we see an arrangement of the gravity system as applied to heating pipes on three successive floors of a building, the return being connected into a Lancashire boiler. The pipe A leading from the top of the boiler is a steam feed to the heating system B, a stop valve being inserted, as shown, near the boiler. The heating pipes are arranged with a continuous fall into the return pipe C, and enters the boiler at some convenient point below the water level, as shown. It will be necessary to insert both a stop valve and a non-return valve on the return pipe, as close to the boiler as possible; and a vent cock should be inserted at the base of the vertical pipe C, for the purpose of blowing through the system, and for starting circulation.

The operation of working is as follows:—We will assume that we admit steam of a boiler pressure of 100 lb. per square inch into the heating pipes from a stop valve close down to the boiler on pipe A; the stop valve on the return pipe C being closed, the

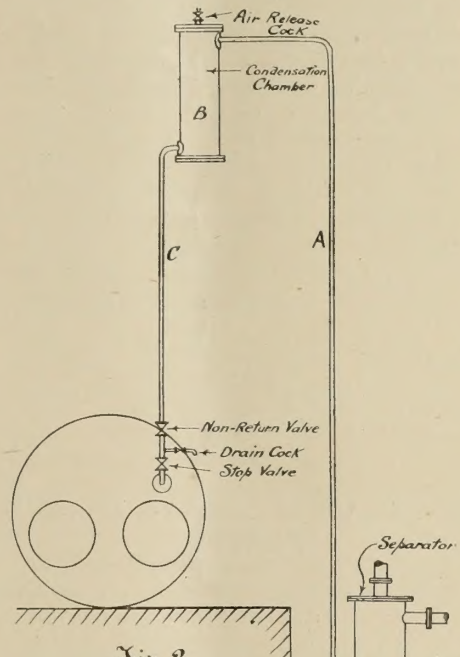

Fig. 2.

drain cock open. Upon the pipes being heated through this drain cock is closed, and the stop valve opened. Then as further condensation is formed in the heating pipes B, it will pass the non-return valve, and so into the boiler.

The Principle of Action.

The principle of such action is that steam acting as a gas, and being lighter than air, rises into the heating pipes, becomes condensed, and drains by its own weight into the return pipe C, thus forming a column of water of a height determined by the vertical pipe A. Supposing that we assume this height to be 25 feet, then a head of water in the pipe of this height is equivalent to a pressure of approximately 11 lb., upon which is superimposed the pressure of the boiler, or, say, 100 lb., less perhaps a loss of four per cent. Assuming, therefore, the boiler pressure to be 96 lb. per square inch at the base of the return pipe C, we should have 96 lb. per square inch due to pressure, plus 11 lb. per square inch due to the head of the column of water in the pipe; or a total pressure of 107 lb. per square inch—more than sufficient over the boiler pressure to overcome whatever frictional resistance is caused, and so permit easily the water to enter the boiler; the temperature of which might reach about 330 deg. Fahr.

The Steam Loop.

The steam loop also is dependent entirely upon gravity for its functions, but it goes a step further, since it is capable of returning water from a point below the level of the boiler.

As will be seen from the diagrammatic sketch, Fig. 2, which show principles only, in its application the loop is formed between an ordinary engine separator, from which the drain is led to the boiler, a pipe A leading to a condensation chamber B, and a return pipe C to the boiler; a similar combination of valves and drain cock as in our previous example being employed.

The principle of working is much the same as in the simple gravity system. Circulation is started by opening the small drain cock, as also the air release cock situated at the top of the chamber B. Steam being admitted to the separator drives out all air imprisoned in the the vertical pipe, condenses in chamber B, and forms a column of water in the pipe C, thus forming a head which, with the pressure of steam upon it, is together greater than that within the boiler. Thus water, as it condenses and fills the condensing chamber, is continually passing down the return pipe, through the non-return valve and into the boiler.

This, of course, is but one of a number of applications of the steam loop, but as this short article is intended only to illustrate principles and operation, its applicability to other items of steam service must be left for another occasion.

A CAUSE OF FAILURE IN BOILER PLATES.

By Walter Rosenhain, D.Sc., F.R.S., and D. Hanson, M.Sc.

(From the National Physical Laboratory.)

(*Continued from Vol. VI., page 458.*)

Since the tensile tests showed little or no departure from the normal in the material of this plate, it became desirable to apply other tests in order to ascertain whether the properties of the steel were really as satisfactory as the tensile tests would indicate. For this purpose an impact test has been used, for although it is recognised that the conditions under which failure occurs in boiler plates possess no apparent resemblance to those of an impact test, yet experience has repeatedly shown that materials which give a low figure under an impact test are liable to fail under apparently static conditions. The form of impact test employed is that known as the International Notched Bar Impact Test, made with a modification of the Charpy impact testing machine, and on specimens measuring 10 millimetres by 10 millimetres in section by 53.3 millimetres in length, having in the middle a rounded notch with a radius of two-thirds of a millimetre. On the material as received this test gave a mean figure of 0.75 kilogrammetre per square centimetre, the actual values obtained being: 0.84, 0.88, 0.66, 1.08, 0.86, 1.20. These figures are, of course, very abnormally low, a reasonable value for a boiler plate of this kind being from 8 to 11 kilogrammetres per square centimetre. It was thought that possibly this low value might be due to cold work which the plate had received, leaving it in a work-hardened and, possibly, internally strained condition. The impact tests were therefore repeated on specimens of the plate which had been annealed for thirty minutes at 550 deg. Cen., in the same way as had been done with the tensile test-pieces. The mean result of six impact tests made on the steel in this condition gives a value of 2.90 kilogrammetres per square centimetre, the actual figures obtained being as follows: 2.10, 3.86, 2.64, 3.36, 3.52, 1.92.

It will be seen that this very low temperature annealing, by removing cold work and internal stress, has improved the impact behaviour of the material quite appreciably, but that, even when thus treated, it is still very far below the normal value for steel of this grade. This is indicated by the impact figures given on samples of the plate after normalising at 900 deg. Cen., when values of 10.78 and 11.72—mean 11.25—kilogrammetres per square centimetre were obtained.

It is evident from these figures that the steel of

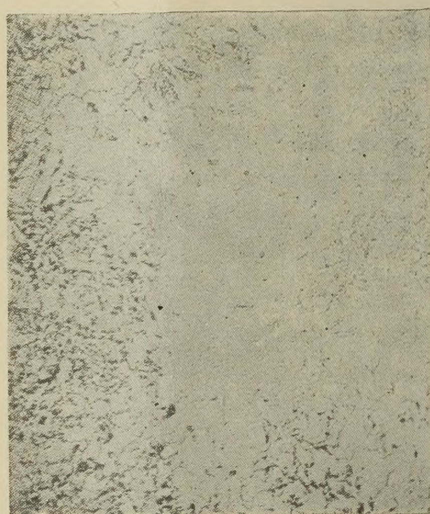

Fig. 3.

the fractured plate is in an abnormally bad condition, presumably as the result of some treatment—thermal or mechanical, or both—which it has received during manufacture, and it became necessary to discover, if possible, the cause of this abnormality.

The general microscopic examination of the steel showed at first sight nothing abnormal. The structure in general transverse and longitudinal section is shown under a magnification of 50 diameters in photomicrographs Figs. 3 and 4. It will be seen that the scale of the structure, so far as ferrite-pearlite distribution is concerned, appears to be satisfactory, but there is a considerable amount of banding present, although this amount is not in itself abnormal for a plate of such large size.

More careful examination of the structure, however, particularly after it had been etched in such a way as to develop the ferrite boundaries, revealed a striking peculiarity. This takes the form of relatively very large ferrite crystals in the carbonless bands of the structure. These are illustrated, under a magnification of 150 diameters, in Fig. 5.

The corresponding grain size of the same material, after normalising, is shown in Fig. 6 under the same magnification. It should be noted, however, that the normalised structure shown in Fig. 6 has been obtained not by treating a small laboratory sample but from a comparatively large piece of the plate about a foot square which had been subjected to the heat treatment described. The most careful study of the steel in both conditions revealed no other difference between the "as received" and normalised conditions. The inference is thus indicated that the abnormal impact behaviour of the steel as received may be due to the development of coarse crystals in the carbonless bands which occur in this material, and the possibility is suggested that the failure of this plate may be connected with the phenomenon of grain growth which has in recent years been discovered in the case of iron and very low carbon steel.

Since the subject of grain growth is of fundamental importance in connection with the further

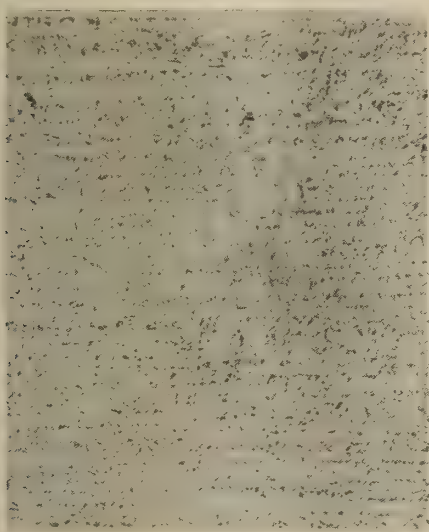

Fig. 4.

investigation of this plate, it will be desirable to refer to it in greater detail at this point.

Phenomena which are now recognised as coming under the general title of grain growth vere discovered and described by Stead* and Charpy†. A considerable advance in our knowledge of the subject was, however, made by Sauveur,‡ who made the well-known experiment of straining by compression a conical piece of nearly pure iron, and subsequently annealing the piece thus treated at a temperature below the lowest critical point. On cutting a section and etching it, a band of very large ferrite crystals was found at one point, and this led to the view that there is a critical amount of plastic deformation which, for a given annealing temperature, below the critical range produces very rapid main growth.

The subject has been more fully investigated by Chappell,§ and has also been dealt with in America by Sherry.‖ The latter author has shown that grain growth occurs, not only in comparatively pure iron, but in any region existing in a mass of mild steel from which pearlite is absent or nearly absent,

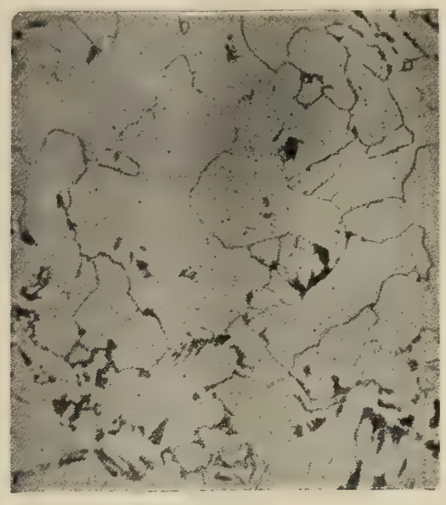

Fig. 5.

i.e., the carbonless bands such as those met with in boiler plates, provided of course that the necessary treatment, consisting of plastic deformation of the right intensity followed by annealing at a correspondingly low temperature, has been applied.

In view of the results obtained by the authors just referred to, the observations made on the boiler plate which forms the subject of this paper at once

Fig. 6.

suggested that the development of coarse ferrite crystals in the carbonless bands of the plate was the result of grain growth following upon deformation in the cold and subsequent low temperature anneal-

* Stead, *Journal of the Iron and Steel Institute*, 1898, No. I. p. 145; *ibid.*, No. II. p. 137.

† Charpy, *Comptes Rendus*, vol. cli.

‡ Sauveur, *Proceedings of the International Congress for Testing Metals, Sixth Congress*, 1912, vol. xi.

§ Chappell, *Journal of the Iron and Steel Institute*, 1914, No. I. p. 460.

‖ Sherry, *Faraday Society*, December, 1916.

ing. When it is borne in mind that this plate was bent cold and then annealed several times in succession, it will be seen that the conditions likely to produce grain growth in carbon-free areas had been present. The authors, however, were not satisfied with a general inference of this kind, but endeavoured experimentally to reproduce the conditions under which the steel had developed the coarse and relatively brittle structure which it possessed when received. For this purpose two series of experiments were undertaken. In both series the material was first normalised in order to destroy the previously existing coarse crystals and to bring the material into the condition in which it gives a satisfactorily high impact figure. Deformation was then applied to the material in two ways; in one case, in the cold (by hammering), and in the second case at a temperature between 600 deg. Cen. and 700 deg. Cen., *i.e.*, below the critical range. Specimens treated in both ways were then annealed at 650 deg. Cen. for thirty minutes. The microstructure was examined both before and after this last

FIG. 7.

annealing, and impact tests were taken on the material at each stage.

The resulting structure in one of the carbonless areas of the specimen which has been hammered in the cold and subsequently annealed at 650 deg. Cen. is shown in Fig. 7 under a magnification of 150 diameters. Comparison with Fig. 6 shows at once that considerable grain growth has taken place, although the resulting grains are not quite so large or well developed as those of Fig. 5. The sample which has been hammered between 600 deg. Cen. and 700 deg. Cen. gives a very similar structure, and the impact figure in this case is brought down to 1.56 kilogrammetre per square centimetre.

In order to test the matter further another series of experiments was undertaken in which varying amounts of mechanical deformation were applied in the cold followed by annealing at 650 deg. Cen. In order, however, to prove that it was not the annealing process alone which resulted in the reduction of the impact figure, the normalised sample was also annealed at 650 deg. Cen. without previous mechanical deformation. The results obtained by impact tests on specimens thus treated are given in Table II. :—

TABLE II.—BOILER PLATE NO. 1.

Treatment.	Resistance to Impact. Square Kilogrammetre per Centimetre.
Normalised at 900° C.	10·46
,, at 900° C.	8·92
Normalised ; annealed at 650° C.	9·04
,, severely deformed ; annealed, 650 C. ...	11·7
,, reduced 12·4 per cent. ; annealed, 650° C.	10·66
,, ,, 7·1 ,, ,, ...	1·44
,, ,, 6·9 ,, ,, ...	10·04
,, ,, 4·9 ,, ,, ...	8·14
,, ,, 3 ,, ,, ...	6·34

In this table the amount of mechanical deformation is measured by percentage reduction of thickness produced by pressing in the cold in a powerful hydraulic press.

The results given in Table II. are instructive. It will be seen that large amounts of reduction actually improve the impact strength slightly, but with decreasing amounts of mechanical deformation followed by low temperature annealing the impact strength is very much reduced, although the lowest value obtained in this way, 6.34 kilogrammetres per square centimetre, is still very much better than that found in the plate in its condition as received, or that described in the hammered sample given above. There is nothing to suggest, however, that hammering, as distinct from such deformation as occurs in cold bending, has any specific effect. It should further be borne in mind that when a thick plate is bent in the cold, a considerable range of plastic deformation is produced, ranging from a maximum at the surface of the plate to zero at the neutral axis. Somewhere within this range the critical deformation, corresponding to the annealing temperature employed, is likely to occur.

(*To be continued.*)

MODERN STEAM TURBINES.

By J. HUMPHREY.

(*Continued from Vol. VI., page 470.*)

Design of Blade Discs.

Considerable ingenuity has been displayed in the design of the discs to which the rings of blades are connected. The use of solid discs is not permissible owing partly to the varying and irregularly distributed temperatures giving rise to stresses and alterations in shape. But apart from temperature fluctuations, solid discs would be subjected to considerable stresses as a result of the centres of the discs being in contact with the high temperature steam, whilst at the circumference there is low pressure steam with a corresponding lower temperature. Under such conditions, discs put into the turbine flat would become dish shaped. A very thick disc would be subjected to severe stresses, and would be liable to crack. To overcome the difficulty the discs are divided into sections, as shown in Fig. 63, from which it will be seen that the ring sections are joined together by means of the expansion rings 1, and expansion troubles are therefore avoided. As explained at the beginning, for admitting steam to the blade

rings holes are provided in the hubs ot the discs, these holes being shown at 2, and also in Fig. 55. With a view to providing for overloading the turbine, however, addition holes are provided as shown at 3 (Fig. 63), so that steam can be admitted directly into a blade ring some distance from the centre ot the disc and thus a larger quantity of steam per unit of time can be passed through the turbine. The centre hole in each disc for the reception of the shaft and the hub is secured to the shaft by round keys, which in turn are retained in position by a locking device screwed into the end of the shaft. The part of the shaft within the turbine, and consequently subjected to the temperature of the steam, is made hollow with the object of accelerating the heating so as to make the fluctuations of temperature in the other direction enlarges the inner passages, but not the outer ones. In this way the entrance and discharge of the steam and at the same time the steam pressure on the labyrinth disc is varied in such a manner that the labyrinth disc fixed on the turbine wheel will automatically occupy the axial position required for making the steam pressure, on the dummy fixed to the turbine wheel, exactly equal to the steam pressure on that side of the turbine disc to which the blade rings are fastened. This position remains constant at all steam pressures, and no thrust bearing is needed for fixing the axial position of the rotors. The labyrinth discs 3 and 4 (Fig. 64) are, as shown in Fig. 62, secured to the turbine wheel and steam chest by means of expansion rings, thus eliminating the heat stresses and consequent

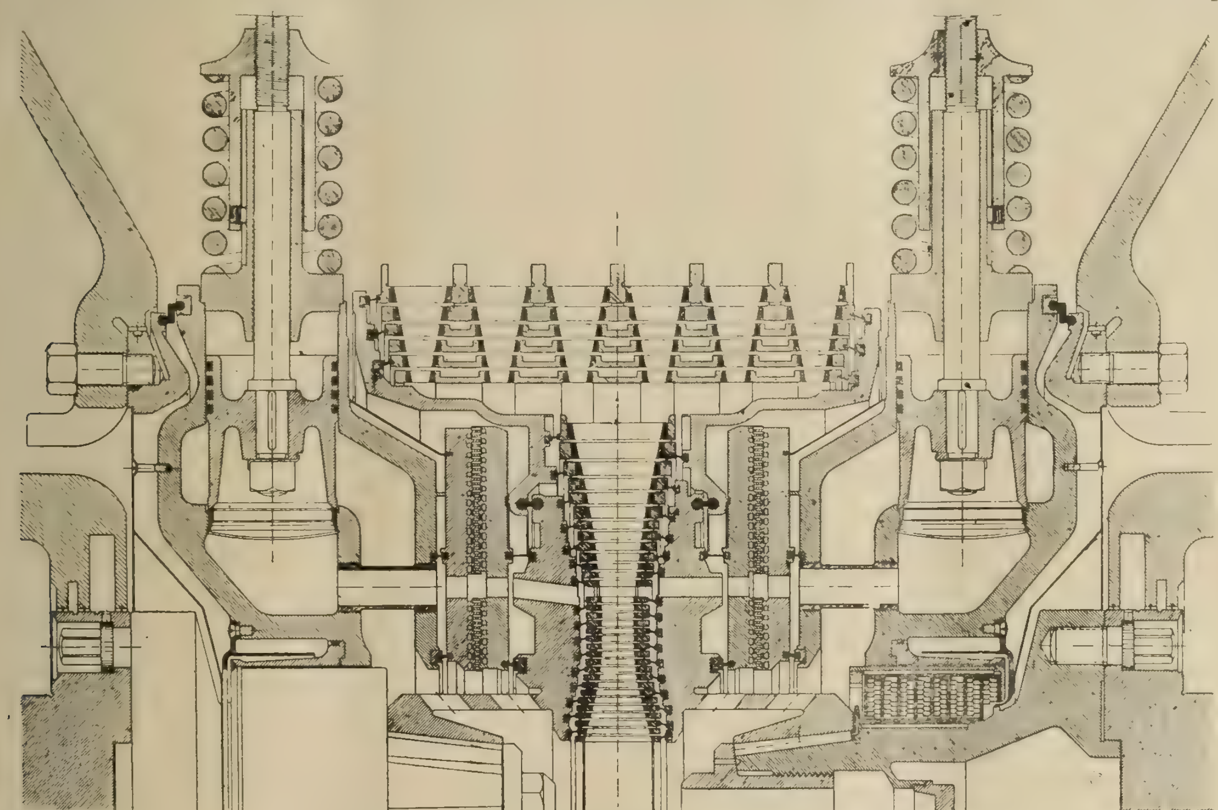

Fig. 62.—Section of Upper Part of a Large Turbine.

the shaft and hub simultaneous, thus avoiding play between the shaft and hub.

In order to balance the turbine wheel axially, two dummy discs are provided, each disc having a number of labyrinth packings. These discs are clearly shown in Fig. 62, and it will be seen that steam is admitted between the discs from the centre of the turbine. Consequently in the inner labyrinth packings there is the full steam pressure, whilst in the remaining packings the pressure gradually decreases in proportion to the distance of the packing from the centre until it finally drops to the pressure of the condenser at the point outside the outermost packing.

The packings are divided into one inner and one outer section, as shown at A and B in Fig. 64. Any axial motion of the rotating wheel affects the clearances in these two sections differently, a movement in one direction increasing the passages in the outer section, but not in the inner one, whilst movement in

alterations of shape. The packing strips 7 are caulked into the annular projections 8 on the labyrinth discs 3. These projections fit with a suitable clearance in the corresponding grooves 9 on the labyrinth disc 4. The thickness of metal in the two labyrinth discs facing each other are so proportioned that any variations in temperature of the steam is transmitted as quickly to one disc as to the other, hence the clearances in the labyrinth packings are not subjected to changes by load variations or by the admission of steam when starting.

It is obvious that in common with all turbines packings must be provided at the points where the shaft passes through the casing. These packings consist of labyrinth rings constructed on the lines shown in Fig. 65. Alternate rings are fixed to the shaft, whilst the intermediate rings are secured to the interior of the stationary packing boxes, twisting of the rings being prevented by the feathers 6 and

7. The design enables a very large number of throttling edges to be contained in a very small space, and as the packing edges are made very thin, no trouble is liable to arise in the event of contact occurring with the ribs of the adjoining ring because the thin metal simply wears away, until the contact is broken. As all the labyrinth rings are of the same thickness, when the steam passes through them they are all heated at the same rate, and consequently the clearances between the ribs is the same, irrespective of whether they are hot or cold. Very little steam leaks past the rings, and that which does succeed in doing so is discharged through pipes to a feed water heater from which the boiler feed is drawn. It will, therefore, be seen that the flow of steam through the packing boxes involves practically no loss nor increased fuel consumption.

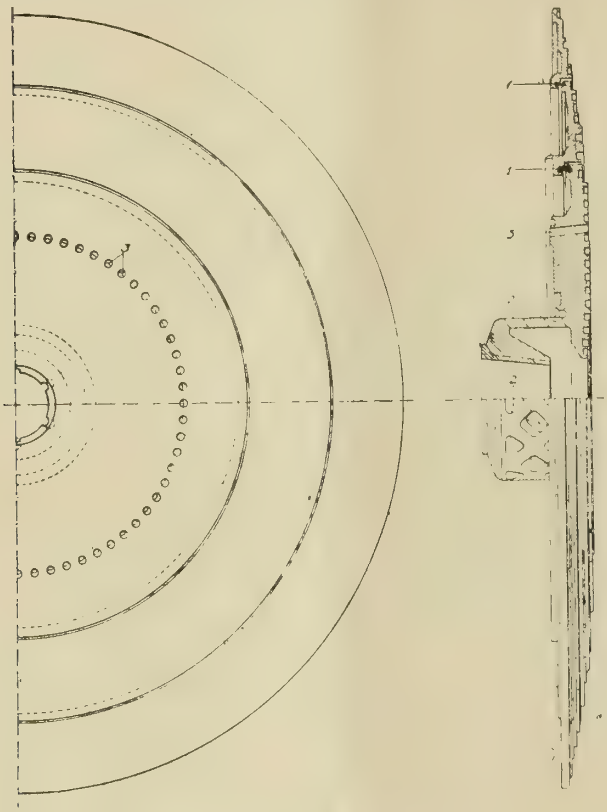

Fig. 63.—Details of a Turbine Disc.

Method of Supplying Steam.

The method of supplying steam to the machine will be understood from Fig. 66, the high pressure steam passing from the admission valve and strainer into the inlet pipe shown in the centre of the turbine discharge, and from here the inlet emerges into two branches, B1 and B2, and then into pipes $b1$ and $b2$, which communicate with the steam chests in the turbine casing, and from these chests the steam passes to the centre of the turbine wheel. By means of special overload valves, to be seen in Fig. 62, steam can be admitted into the overload channels previously referred to, and when desired these valves can be designed to open and close automatically. The exhaust steam passes from the outermost blade ring through the annular space between the ring and casing, and finally flows into the condenser through the exhaust branch below, special discharge pipes being provided for conveying the steam leakage from the shaft packings to the feed water heater.

It will be gathered from Fig. 66 that the entire turbine is located in the centre of the exhaust passage, with the result that the outer parts of the

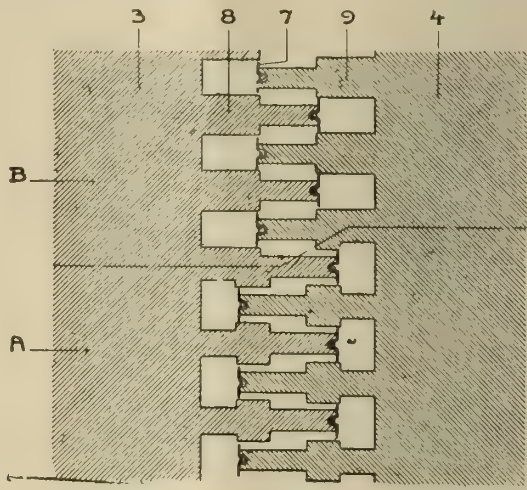

Fig. 64.—Details of Labyrinth Dummy Packing.

casing are kept at a low temperature, and do not, therefore, require any heat insulation. The only parts that require insulation are the admission valve and strainer, the pipes conducting the high pressure steam through the exhaust channel to the centre of the turbine wheel, and the annular steam chests of small diameter at the outer sides of the turbine wheels. Furthermore, the transmission of heat through conduction from the internal parts of the turbine to the outer portions is impeded by the small

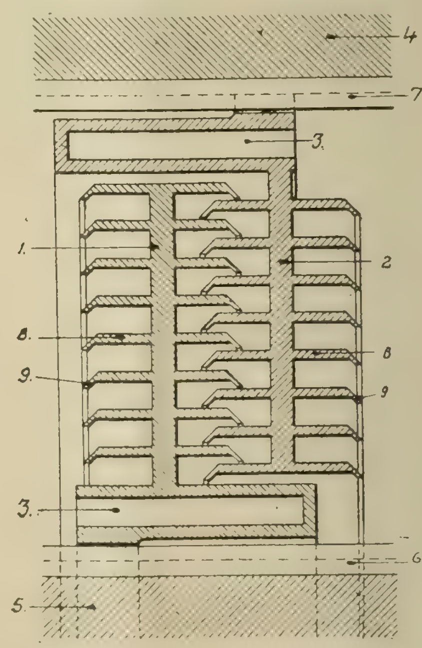

Fig. 65.—Cross Section of Shaft Packing.

sectional area of the expansion rings previously described, and in consequence the internal heat losses due to conduction of heat from the hot high pressure parts to the comparatively cool low pressure parts are reduced to a minimum. There are also

several special features worthy of mention in connection with the main bearings. A longitudinal section of one of the bearings is shown on the left of Fig. 66, and a cross section is given in Fig. 67. The

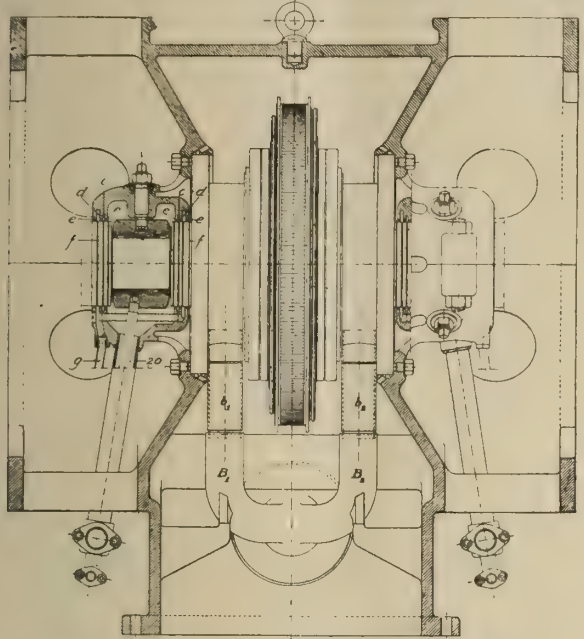

FIG. 66.—SECTION OF A 1000 KILOWATT TURBINE.

bearings, it will be noticed, have adjusting screws, as shown at 1, there being in all four of these screws, two adjusting the bottom part of the bearing 7, whilst the other screws adjust the top part 6. The bolts 4 are tapered, and fit accurately in reamered holes, thus at the same time serving as dowels for the

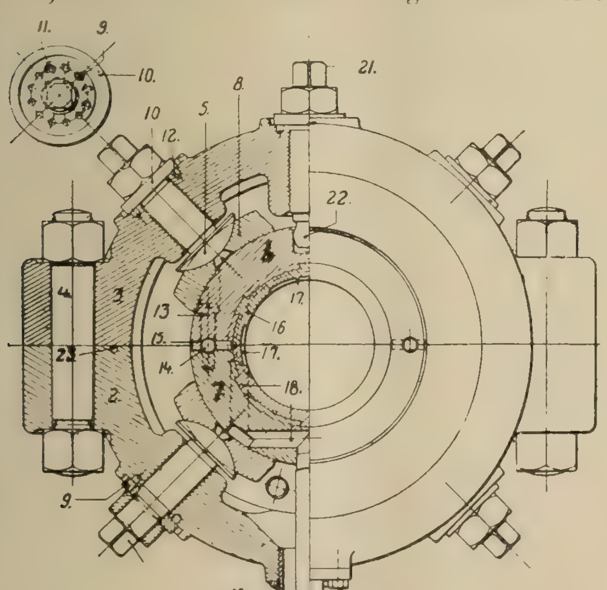

FIG. 67.—CROSS SECTION OF SHAFT BEARING.

cap 3. The adjusting screws are provided with spherical heads 5 at their inner ends. Between the adjusting screws 1 and the top and bottom halves of the bearings 6 and 7 are washers 8, whilst at the other end of the adjusting screws are locking washers 10. The adjusting screws are locked by the small set screws 9, the locking washer having a square hole and fitting accurately on the square part of the adjusting screw. The washers have 12 holes, and 11 holes are drilled in the bearing surface upon which they rest. It is, therefore, possible to lock any washer and the corresponding adjusting screw in no fewer than 132 different positions for every revolution, and a very fine adjustment of the bearing is thus made possible without necessitating an exceptionally fine thread on the adjusting screws. The bearings are locked axially and against torsion by means of the screw 21, which has a spherical end fitting in a corresponding recess in the upper half 6 of the bearing. As the ball 22 is turned eccentrical to the axis of the adjusting screw, the bearing can be moved slightly in an axial direction by turning the screw, which is subsequently locked by a washer in the same manner as the adjusting screws 1. The two halves of the bearing are held together by the screw 13, and their position is determined once and for all by the dowel pins 14 and 15. The anti-friction metal 16 is cast into the two halves of the bearing, which are provided with grooves of dovetail section, and after boring oil grooves 17 are cut parallel to the shaft.

(To be continued.)

THE INSTALLATION AND OPERATION OF STATIC TRANSFORMERS.

By F. ASHTON.

(Continued from Vol. VI., page 432.)

The T-Connection.

It has been shown that three-phase currents can be transformed by two transformers connected V-fashion, but whilst this connection may prove useful in the case of emergency, it is not, for reasons already explained, to be recommended for permanent service. Another and rather better method of dealing with three-phase currents, with only two transformers, is to employ the T-connection, as shown in Fig. 6. It will be seen that one transformer is connected across two of the line wires, both on the primary and secondary sides, whilst the other transformer is joined to the third line wire and the middle point of the first transformer, which is called the main transformer. The second transformer connected to the middle point of the main transformer is called the "teaser," and operates at 86·6 per cent of the line voltage. The teaser may be designed for 86·6 of the main voltage, or may have 86·6 tapping, but it is possible in the event of one of the transformers of a three-phase bank burning out, to operate the remaining two connected in accordance with Fig. 6, provided, of course, that one of the remaining sound transformers has a 50 per cent tapping. The effect on the teaser transformer will be that it will work, under these conditions, at a lower flux density than usual, and for this reason the efficiency obtained with the T-connection is slightly better than that obtained with the V- or open-delta connection. The capacity of two transformers connected T-fashion is the same as that of two transformers connected open-delta fashion, namely, 86·6 per cent of the single-phase

rating. The prime requisite for the T-connection of transformers for three-phase work is met when the two transformers possess the same ratio of primary to secondary turns, and a tapping is brought out from the centre point of one transformer. The two halves of both the primary and secondary windings of the latter transformer should be well inter-spaced to prevent excessive magnetic leakage. Although it is often stated that the teaser transformer should be wound for exactly 86·6 per cent of the line voltage, such, in point of fact, is not the case. Two identical transformers may be used, the one acting as the teaser working at comparatively low flux density. With the T-connection the neutral point is readily accessible, it being, of course, the point where the teaser transformer joins the main transformer. The T-connection may be used for transforming three-phase current into two-phase current, or *vice-versâ*, but this is a matter which will be dealt with under the heading of phase transformation.

Single-phase Connections.

Transformers, as pointed out in a previous article, may have their windings divided into sections, and

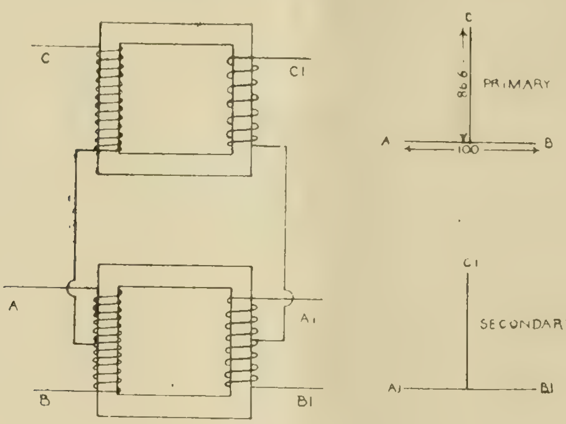

Fig. 6.—The "T" Connection.

these sections may be connected up in different ways in order to obtain different results. In Fig. 7, for instance, a transformer is shown wound for 2,000 volts on the primary side, and 200 volts on each of its secondary sections. In this particular case, the secondary sections are connected in parallel, and the total secondary pressure is therefore 200 volts. But 400 volts might be obtained from the same transformer by connecting the secondary sections in series, when the current would, of course, be reduced one-half. If, under the latter conditions, a tapping be brought out from the point where the two secondary sections are joined, as shown in Fig. 8, then two secondary pressures become available—400 volts between the outer ends of the secondary sections and 200 volts between either of the outer leads and the middle wire. Of course, if there is a different ratio between the primary and secondary turns, then the secondary voltages will differ accordingly, but the pressure between either of the outer leads and the middle conductor will always be half that across the outer ends of the two secondary coils. This arrangement of connections obviously lends itself to three-wire working, just as in the case of a three-wire continuous-current system. If the two secondary sides of the transformer be equally loaded, then no current will return by way of the middle wire, but if the two secondary sections be unequally loaded, then the middle wire deals with the difference. Motors might be fed from the outer conductors at 400 volts, or whatever secondary voltage the transformer happens to be wound for; whilst

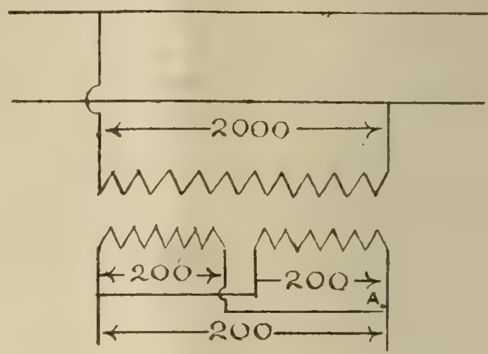

Fig. 7.—Secondary Windings in Parallel.

lamps rated at half the total secondary pressure might be equally divided between the middle and outer conductors. The centre point E of the secondary can be earthed, and under these conditions no part of the secondary windings can be subjected to a greater stress than 200 volts. But if the secondary point of the secondary is not earthed and one of the outer leads becomes accidentally earthed, then the potential stress between the iron and secondary coils is doubled. This, of course, is independent of the potential stress between the primary and secondary windings, which is equal to the primary voltage plus or minus the secondary voltage, according to the arrangement and connections of the coils. But it is to be noted that by earthing the secondary side of the transformer it will not be possible, except under very exceptional circumstances, for the pressure on the secondary to exceed the normal value, even if the high and low-pressure circuits are brought into contact. If, on the other hand, the secondary is not earthed, and the insulation of the transformer fails, the primary pressure

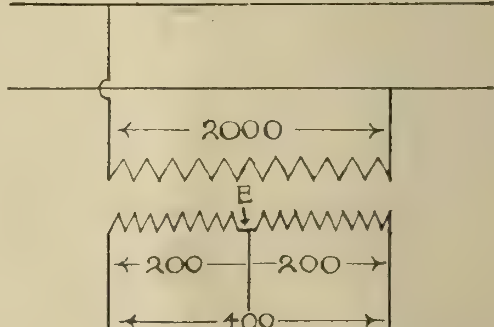

Fig. 8.—Transformer Connections for Three-wire Working.

may be impressed on the secondary circuit, and fatal shocks may be received by operators. When transformers are operated on a two-wire system, and there is no connection at the centre of the secondary, the latter may be earthed at one of its ends, but when there is a centre connection (see Fig. 8) then the secondary may be earthed at the point E.

Weights of Lengths of Rolled Steel Sections.

Beams 14 in. × 6 in. × 57 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	5 0 10	10 0 20	15 1 2	1 0 1 12	1 5 1 22	1 10 2 4	1 15 2 14	2 0 2 24	2 5 3 6	0
1	0 2 1	5 2 11	10 2 21	15 3 3	1 0 3 13	1 5 3 23	1 11 0 5	1 16 0 15	2 1 0 25	2 6 1 7	1
2	1 0 2	6 0 12	11 0 22	16 1 4	1 1 1 14	1 6 1 24	1 11 2 6	1 16 2 16	2 1 2 26	2 6 3 8	2
3	1 2 3	6 2 13	11 2 23	16 3 5	1 1 3 15	1 6 3 25	1 12 0 7	1 17 0 17	2 2 0 27	2 7 1 9	3
4	2 0 4	7 0 14	12 0 24	17 1 6	1 2 1 16	1 7 1 26	1 12 2 8	1 17 2 18	2 2 3 0	2 7 3 10	4
5	2 2 5	7 2 15	12 2 25	17 3 7	1 2 3 17	1 7 3 27	1 13 0 9	1 18 0 19	2 3 1 1	2 8 1 11	5
6	3 0 6	8 0 16	13 0 26	18 1 8	1 3 1 18	1 8 2 0	1 13 2 10	1 18 2 20	2 3 3 2	2 8 3 12	6
7	3 2 7	8 2 17	13 2 27	18 3 9	1 3 3 19	1 9 0 1	1 14 0 11	1 19 0 21	2 4 1 3	2 9 1 13	7
8	4 0 8	9 0 18	14 1 0	19 1 10	1 4 1 20	1 9 2 2	1 14 2 12	1 19 2 22	2 4 3 4	2 9 3 14	8
9	4 2 9	9 2 19	14 3 1	19 3 11	1 4 3 21	1 10 0 3	1 15 0 13	2 0 0 23	2 5 1 5	2 10 1 15	9

Weight of Beam advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight	lbs.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight
Weight	4·75	9·50	14·25	19·00	23·75	1 0·50	1 5·25	1 10·0	1 14·75	1 19·50	1 24·25	2 1	Weight

Weights of Lengths of Rolled Steel Sections.

Beams 14 in. × 6 in. × 57 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 10 3 16	5 1 3 4	7 12 2 20	10 3 2 8	12 14 1 24	15 5 1 12	17 16 1 0	20 7 0 16	22 18 0 4	0
10	0 5 0 10	2 15 3 26	5 6 3 14	7 17 3 2	10 8 2 18	12 19 2 6	15 10 1 22	18 1 1 10	20 12 0 26	23 3 0 14	10
20	0 10 0 20	3 1 0 8	5 11 3 24	8 2 3 12	10 13 3 0	13 4 2 16	15 15 2 4	18 6 1 20	20 17 1 8	23 8 0 24	20
30	0 15 1 2	3 6 0 18	5 17 0 6	8 7 3 22	10 18 3 10	13 9 2 26	16 0 2 14	18 11 2 2	21 2 1 18	23 13 1 6	30
40	1 0 1 12	3 11 1 0	6 2 0 16	8 13 0 4	11 3 3 20	13 14 3 8	16 5 2 24	18 16 2 12	21 7 2 0	23 18 1 16	40
50	1 5 1 22	3 16 1 10	6 7 0 26	8 18 0 14	11 9 0 2	13 19 3 18	16 10 3 6	19 1 2 22	21 12 2 10	24 3 1 26	50
60	1 10 2 4	4 1 1 20	6 12 1 8	9 3 0 24	11 14 0 12	14 5 0 0	16 15 3 16	19 6 3 4	21 17 2 20	24 8 2 8	60
70	1 15 2 14	4 6 2 2	6 17 1 18	9 8 1 6	11 19 0 22	14 10 0 10	17 0 3 26	19 11 3 14	22 2 3 2	24 13 2 18	70
80	2 0 2 24	4 11 2 12	7 2 2 0	9 13 1 16	12 4 1 4	14 15 0 20	17 6 0 8	19 16 3 24	22 7 3 12	24 18 3 0	80
90	2 5 3 6	4 16 2 22	7 7 2 10	9 18 1 26	12 9 1 14	15 0 1 2	17 11 0 18	20 2 0 6	22 12 3 22	25 3 3 10	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight
Weight	25 8 3 20	50 17 3 12	76 6 3 4	101 15 2 24	127 4 2 16	152 13 2 8	178 2 2 0	203 11 1 20	229 0 1 12	254 9 1 4	Weight

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Weights of Lengths of Rolled Steel Sections.

Beam 14 in. × 6 in. × 46 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	Ft.
0	..	4 0 12	8 0 24	12 1 8	0 16 1 20	1 0 2 4	1 4 2 16	1 8 3 0	1 12 3 12	1 16 3 24	0
1	0 1 18	4 2 2	8 2 14	12 2 6	0 16 3 10	1 0 3 22	1 5 0 6	1 9 0 18	1 13 1 2	1 17 1 14	1
2	0 3 8	4 3 20	9 0 4	13 0 16	0 17 1 0	1 1 1 12	1 5 1 24	1 9 2 8	1 13 2 20	1 17 3 4	2
3	1 0 26	5 1 10	9 1 22	13 2 6	0 17 2 18	1 1 3 2	1 5 3 14	1 9 3 26	1 14 0 10	1 18 0 22	3
4	1 2 16	5 3 0	9 3 12	13 3 24	0 18 0 8	1 2 0 20	1 6 1 4	1 10 1 16	1 14 2 0	1 18 2 12	4
5	2 0 6	6 0 18	10 1 2	14 1 14	0 18 1 26	1 2 2 10	1 6 2 22	1 10 3 6	1 14 3 18	1 19 0 2	5
	2 1 24	6 2 8	10 2 20	14 3 4	0 18 3 16	1 3 0 0	1 7 0 12	1 11 0 24	1 15 1 8	1 19 1 20	6
7	2 3 14	6 3 26	11 0 10	15 0 22	0 19 1 6	1 3 1 18	1 7 2 2	1 11 2 14	1 15 2 26	1 19 3 10	7
8	3 1 4	7 1 16	11 2 0	15 2 12	0 19 2 24	1 3 3 8	1 7 3 20	1 12 0 4	1 16 0 16	2 0 1 0	8
9	3 2 24	7 3 6	11 3 18	16 0 2	1 0 0 14	1 4 0 26	1 8 1 10	1 12 1 22	1 16 2 6	2 0 2 18	9

Weight of Beam advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight
	3·83	7·66	11·49	15·32	19·15	22·98	26·81	1 2·64	1 6·47	1 10·30	1 14·13	1 17·96	

Weights of Lengths of Rolled Steel Sections.

Beam 14 in. × 6 in. × 46 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 1 0 8	4 2 0 16	6 3 0 24	8 4 1 4	10 5 1 12	12 6 1 20	14 7 2 0	16 8 2 8	18 9 2 16	0
10	0 4 0 12	2 5 0 20	4 6 1 0	6 7 1 8	8 8 1 16	10 9 1 24	12 10 2 4	14 11 2 12	16 12 2 20	18 13 3 0	10
20	0 8 0 24	2 9 1 4	4 10 1 12	6 11 1 20	8 12 2 0	10 13 2 8	12 14 2 16	14 15 2 24	16 16 3 4	18 17 3 12	20
30	0 12 1 8	2 13 1 16	4 14 1 24	6 15 2 4	8 16 2 12	10 17 2 20	12 18 3 0	14 19 3 8	17 0 3 16	19 1 3 24	30
40	0 16 1 20	2 17 2 0	4 18 2 8	6 19 2 16	9 0 2 24	11 1 3 4	13 2 3 12	15 3 3 20	17 5 0 0	19 6 0 8	40
50	1 0 2 4	3 1 2 12	5 2 2 20	7 3 3 0	9 4 3 8	11 5 3 16	13 6 3 24	15 8 0 4	17 9 0 12	19 10 0 20	50
60	1 4 2 16	3 5 2 24	5 6 3 4	7 7 3 12	9 8 3 20	11 10 0 0	13 11 0 8	15 12 0 16	17 13 0 24	19 14 1 4	60
70	1 8 3 0	3 9 3 8	5 10 3 16	7 11 3 21	9 13 0 4	11 14 0 12	13 15 0 20	15 6 1 0	17 17 1 8	19 18 1 16	70
80	1 12 3 12	3 13 3 20	5 15 0 0	7 16 0 8	9 17 0 16	11 18 0 24	13 19 1 4	16 0 1 12	18 1 1 20	20 2 2 0	80
90	1 16 3 24	3 18 0 4	5 19 0 12	8 0 0 20	10 1 1 0	12 2 1 8	14 3 1 16	16 4 1 24	18 5 2 4	20 6 2 12	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb	t. c. q. lb.	t. c. q. lb.	Weight
	20 10 2 24	41 1 1 20	61 12 0 16	82 2 3 12	102 13 2 8	123 4 1 4	143 15 0 0	164 5 2 24	184 16 1 20	205 7 0 16	

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DRAUGHTSMEN.—A Controlled Establishment in the West Riding of Yorkshire engaged on important high priority work require the services of a competent MAN, with first-class experience in general engineering work; also Experienced MAN for medium-size machine tool work; a LADY TRACER is also required. The above positions are permanent to reliable individuals. No person already on Government work will be engaged.—Apply, stating full particulars, to your nearest Employment Exchange, mentioning A 4965.

TRADE ITEMS, NOTES, &c.

Collection of Controlled Scrap.—The Ministry of Munitions announces that a large number of metal merchants have been authorised to purchase and collect controlled scrap metals in quantities below those scheduled in the Prevention of Crimes Act, 1871; and all persons having in their possession small quantities of scrap copper and lead are requested to dispose of the same to one of the duly authorised merchants as early as possible. Collecting merchants who desire to be authorised to collect scrap in small quantities should apply to the Controller of Non-Ferrous Materials Supply, Room 620, 8, Northumberland Avenue, London, W.C.2.

Sea Water and Ferro-concrete. A question of great interest in connection with this matter was discussed lately before the Faraday Society by Professor Creighton, of Swarthmore College, Pennsylvaia. He outlined the process of the corrosion of iron by brine, and pointed out that, in addition, auto-electrolysis may occur owing to the electrical potential differences which exist in commercial forms of iron as the result of the presence of segregated impurities. These differences, which are augmented by chlorides of the alkali metals, bring about galvanic action, which causes the iron to go into solution at certain points with formation of oxide. Reinforced concrete, therefore, which comes in contact with brine or sea water will begin to deteriorate. As both iron oxide and the hydrated oxide occupy a larger volume than the corresponding amount of iron, there will be developed an enormous expansive force, which is sufficient to crack the strongest concrete and force it away from the reinforcing rods. The more porous the concrete, the more rapidly will this disintegration set in. The durability of reinforced-concrete ships is therefore a matter of considerable doubt, unless the sea water is prevented from coming in contact with the reinforcements. Such prevention may be effected by coating the reinforcements with a protective paint, or by applying to the outer surface of the concrete some material that will render it waterproof. The concrete should undoubtedly be made from cement of fine pulverisation, low in alumina and high in silica, as free as possible from gypsum, absolutely free from lime, slow in setting, and quick in hardening.

Indian Portland Cement.—A report, issued by the Indian Government, of tests by Mr. Musgrave, Alipore, states that he finds that Indian Bundi and Katni cements, as at present manufactured, are equal to the best English brands; also that the ame is true of Porbander cement, except as regards its tensile strength, which is somewhat low. All these cements are sound, reliable, and suitable for every class of work. Imported cements are not infrequently found to have deteriorated during a voyage, and Indian cements offer advantages in this respect also. When the article has to be conveyed long distances by rail from the factory to the consumer, the freight charges add greatly to the cost, and for this reason it is desirable that cement factories should be distributed over the country as widely as possible.

Concrete Standard and Fabricated Ships. Lord Pirrie, Controller-General of Merchant Shipbuilding, in the course of a statement he made on August 8th, referred to the steps taken to secure the present marked acceleration in output. He continued: "We have recently begun the building in this country of small concrete ships. These ships are being constructed, for the most part, in large wooden moulds (technically known as 'shuttering'), into which the steel rods for reinforcement are placed, and the concrete is afterwards poured in. We have at present fifty-six concrete vessels actually under construction, and have made arrangements for numerous other vessels to follow. The advantages of standard ships are that repeat vessels can be constructed with greater ease, and all the machinery and auxiliary fittings for each type of ship are interchangeable. Twelve months ago the number of standard ships under construction was 26 per cent of the total, and to-day this proportion has increased to 74 per cent. The fabricated ship carries the principle of 'standardisation' considerably further. This type of ship was originally designed for the national yards, but private shipbuilders have asked to be allowed to build them, and already we have eleven fabricated ships on the stocks in private yards, for which units are being used which were originally ordered for the national yards."

Polarity.

Of course, in paralleling two transformers or the sections of a single transformer, it is necessary to see that the leads that are connected together have the same polarity. The voltages of the different transformers must naturally also be equal. Take the case shown in Fig. 7, for example, and assume that all the secondary connections are made with the exception

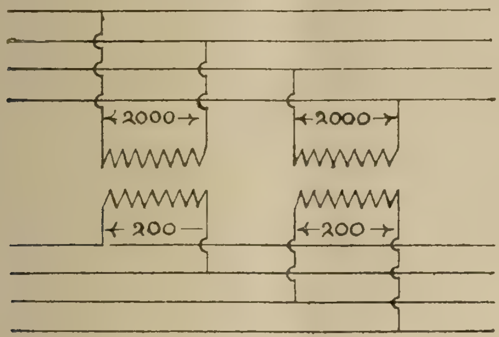


Fig. 9.—Two-phase Connections.

of joining the right-hand lead of the left-hand section up to the point A. It is evident that if the polarity be correct there should be no difference of potential measured at the point A. If, however, the polarity be incorrect, then clearly the sum of the two voltages due to the right and left-hand sections will be established at A, and on connecting up at this point there would be a short-circuit. It is, therefore, unsafe to make such transformer connections before applying a polarity test. One method of doing this is to insert a fuse in the circuit before making the final permanent connection, and if the fuse blows, then clearly the polarity is incorrect, and two of the leads must be reversed. If, on the other hand, the fuse does not blow, then the connections may be completed without reversing the leads. If, when paralleling two transformers, the secondaries are wound similarly with respect to the primaries, the transformers should be connected up symmetrically, but if one were wound relatively opposite to the

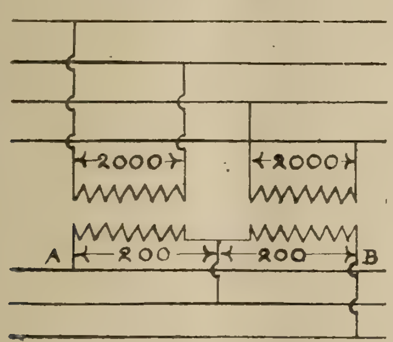


Fig. 10.—Two-phase Three-wire Connections.

other, the effect of symmetrical connection would obviously be to put the two transformers in series on a closed circuit, and a heavy short-circuit current would result. But by testing the connections in the manner described this can be avoided. Much care must be exercised in this direction when coupling up three-phase transformers, but this is a matter which will be dealt with later.

Two-phase Connections.

The two-phase system is not used to anything like the same extent as the three-phase system, but it is desirable that it should be dealt with. As is well known, in this case there are two separate electromotive forces, differing in phase by 90 degrees. The two circuits are often kept quite separate, as shown in Fig. 9, one transformer being used for one of the phases and a second transformer for the other phase. There are then four primary and secondary leads, and the ratio between the primary and secondary voltages is, of course, determined by the ratio of the transformer turns in precisely the same way as on a single-phase or three-phase system. But frequently the secondary windings of the two transformers are combined, as shown in Fig. 10, so that the low-tension current is dealt with by three wires. This connection, however, has an effect upon the voltage which must be taken into account when purchasing transformers that are to be operated in this manner. What this effect is will readily be understood from Fig. 11, where the lines V1 and V2 represent the voltages at the secondary terminals of the two transformers. These voltages, let it be noted, are dis-

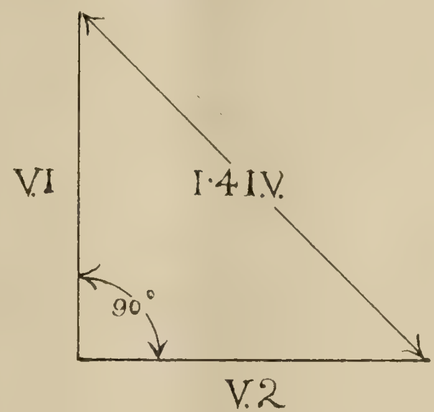


Fig. 11.—Diagram showing the Voltage Relations of a Two-phase Circuit.

placed by 90 electrical degrees, so that instead of being added together numerically, they must be added vectorially. Obviously, therefore, the voltage across the outer transformer leads AB (Fig. 10) will not be twice the voltage across either of the secondaries, but $\sqrt{2}$, or 1·41 times this voltage. Unlike the three-phase system, therefore, the voltage between any two line wires is not equal, the voltage between the outer wires AB being greater than that between either of the outer wires and the middle wire. Furthermore, if the load be balanced, the current in the middle wire is 1·41 times the current in either of the outer wires. The primaries of two transformers working on a two-phase system may also be connected as the secondaries are shown connected in Fig. 10, so that the high-tension current can also be fed in with only three wires, but this arrangement is very seldom adopted.

(To be continued.)

Reduction in Official Price of Aluminium.—The Minister of Munitions announces that the control price of aluminium ingots of 98-99 per cent purity will be reduced as from the 1st January, 1919, from £225 per ton to £200 per ton, carriage paid to consumers' works. The price of remelted aluminium scrap and swarf ingots will remain as at present.

GOVERNORS AND GOVERNING MECHANISM.

By A. Houlson.

(Continued from Vol. VI., page 464.)

A Loaded Hartnell Governor.

Fig. 22 shows a spring-loaded Hartnell governor and Table 1 gives the calculations for the same. Data which might, with advantage, be added to the table would be the cut-off of the steam valve at each position and the brake horse-power. The Hartnell governor may be designed with almost any degree of sensitiveness and stability, limited, of course, only by the friction. Mr. Hartnell advises that the angle of the bell cranks θ, Fig. 22 should be made 6 deg. greater than a right angle at the mean radius to give regularity. Also, the least radius R should be equal to the travel T to give maximum power for the least dimensions. The ball bearing at the sleeve should be noticed, knife edges for pin joints, and ball bearings for revolving spindles are being adopted in all recent designs of governors. When an expansion link or other heavy gear is used with a Porter, Proëll, or Hartnell governor, it is usual to employ a balance weight to neutralise the effect of disturbing forces as much as possible. (See Fig. 23.)

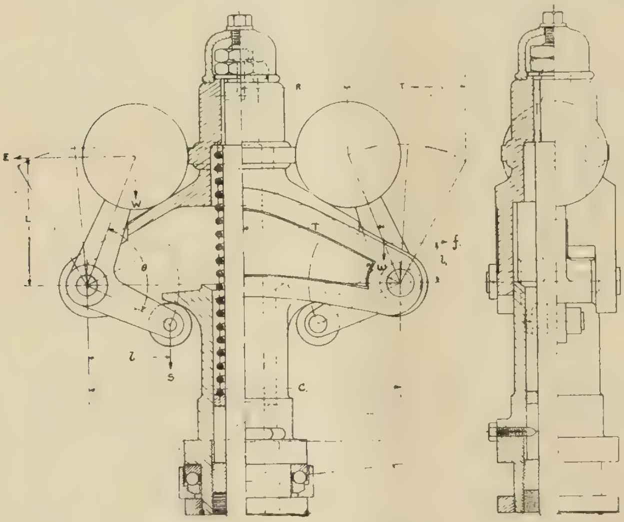


Fig. 22.—Governors.

It must be remembered that, in a spring-loaded governor, one spring only will give regularity to any governor when run at the speed it was originally designed for. To increase or diminish the speed of a Hartnell governor it is better to use stiffer or weaker springs than to screw or unscrew the existing spring.

Fig. 24 shows an actual stability diagram from a Hartnell governor. The full line AB is the curve of centrifugal force, assuming friction to be zero. The two lines above and below AB, and parallel to the latter, are the curves of centrifugal force, exerted by the governor weights in rising or falling.

The line AB may be produced until it cuts the base line in C. The distance OC will then represent the initial compression on the spring referred to the governor weights. By drawing two lines DE and FG parallel to AB to represent the same spring with a greater or less initial compression it will be seen that a small initial compression makes for a more stable governor. A stiffer spring will increase the speed variation if the speed at mid-position and the lift are unaltered. It also has the following effect:

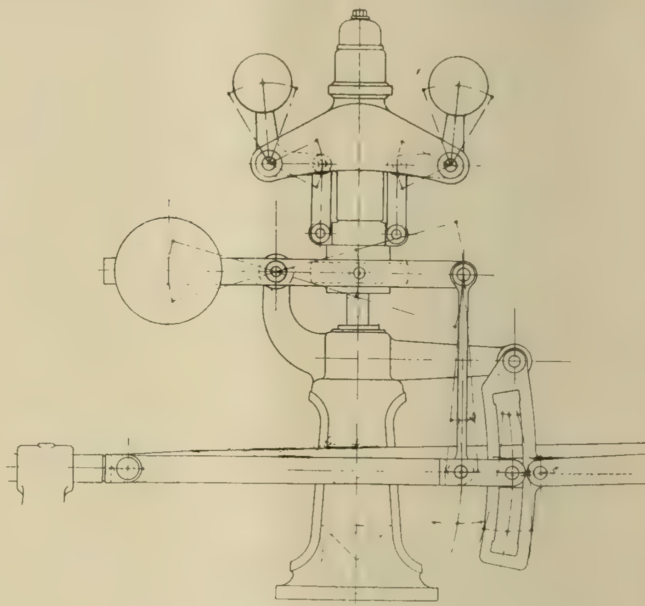


Fig. 23.—Governors.

Suppose the weaker spring (which was in at first) gave an equal variation above and below mean speed, then we find that the stiffer spring will give a small variation from the mean speed above the latter, and a large variation below.

Table 2 gives dimensions of some Hartnell governors.

Formulæ for Buss and Proell Governors.

Buss: if, in Fig. 20, a is the length of the short horizontal arm, and b is the length of the weight arm, θ the angle between the arms a and b; and α the angle which the arm b makes with the vertical at in position, as shown; m the distance from the vertical

TABLE 1.—Hartnell Governor to Fig. 22.

Position Balls	In.	Mid.	Out.
Range Speed	2% below Normal.	Normal.	2% above Normal.
R.P.M.	N_1	N	N_2
C.F. Governor Balls	$\cdot 00034\ WRN^2 = F.$		
Pull on Sleeve due to C.F. Balls	$F \times \frac{L}{l} = S$		
C.F. Governor Arms	$\cdot 00034\ wrN^2 = f.$		
Pull on Sleeve due to C.F. Arms	$f \times \frac{l_1}{l} = S_2$		
Total Sleeve Pull	$S_1 + S_2 = S.$		
Spring Load	S — Weight Sleeve.		
Spring Compression	Initial.	Mean.	Final.

TABLE 2.—HARTNELL GOVERNORS.

Lift of Govr.	R.P.M.	Diam. of Ball.	C.	R.	T.	L.	l.
$1\frac{7}{8}$	350	$2\frac{1}{2}$	$7\frac{1}{2}$	$2\frac{17}{32}$	$2\frac{13}{16}$	$3\frac{1}{4}$	$2\frac{3}{16}$
$2\frac{1}{4}$	325	3	9	$3\frac{1}{32}$	$3\frac{3}{8}$	$3\frac{15}{16}$	$2\frac{5}{8}$
$2\frac{5}{8}$	300	$3\frac{1}{2}$	$10\frac{1}{2}$	$3\frac{9}{16}$	$3\frac{7}{8}$	$4\frac{9}{16}$	$3\frac{1}{16}$
3	275	4	12	$4\frac{1}{16}$	$4\frac{1}{2}$	$5\frac{1}{4}$	$3\frac{1}{2}$
$3\frac{3}{8}$	250	$4\frac{1}{2}$	$13\frac{1}{2}$	$4\frac{5}{8}$	5	$5\frac{7}{8}$	$3\frac{15}{16}$
$3\frac{3}{4}$	225	5	15	$5\frac{1}{8}$	$5\frac{5}{8}$	$6\frac{9}{16}$	$4\frac{3}{8}$

Dimensions in inches.

axis of the governor to the pivot of the bell-crank lever LC; F the centrifugal force of one weight; W the weight of one ball; Q the weight of sleeve + initial

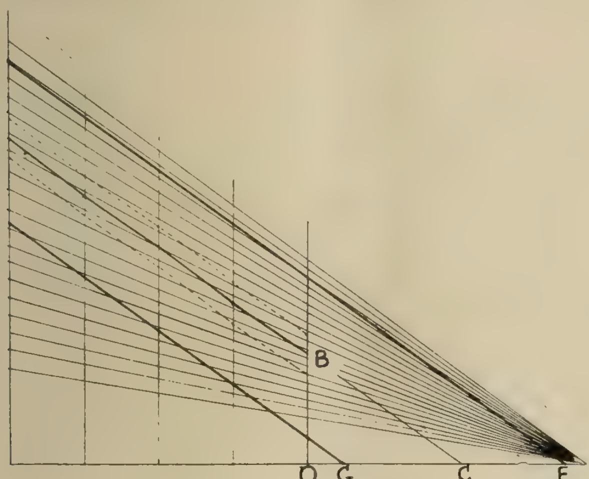


FIG. 24.—GOVERNORS.

compression of spring; R the total friction; N the revolutions per minute. Then the reaction

$$S = W + \frac{Q + R}{2}$$

the plus sign before R indicates that the governor is rising. Taking moments about the pivot of the bell crank—

$$F\ b \cos \alpha + W\ b \sin \alpha - \left(W + \frac{Q + R}{2}\right) a \sin (\theta + \alpha = O$$

$$F\ b \cos \alpha = \left(W + \frac{Q + R}{2}\right) a \sin (\theta + \alpha) - W\ b \sin \alpha$$

$$F = \frac{\left(W + \frac{Q + R}{2}\right) a \sin (\theta + \alpha) - W\ b \sin \alpha}{b \cos \alpha}$$

Also $\quad F = {\cdot}00034\ W\ (m - b \sin \alpha)\ N^2$

Therefore $N = \sqrt{\dfrac{\left(W + \frac{Q + R}{2}\right) a \sin (\theta + \alpha) - W\ b \sin \alpha}{{\cdot}00034\ W\ (m - b \sin \alpha)\ (b \cos \alpha)}}$

An Early Form of Proell Governor.

Proëll: Fig. 25 shows diagramatically the earliest form of Proëll governor. The balls do not move in a straight line, but in a curve as shown. The instantaneous centre of the link BC is at I, and by taking moments about this point when the governor is rising,

$$Fy = \frac{Q + R}{2} x + Wa$$

from which $N = \sqrt{\dfrac{2937 \left(\frac{Q + R}{2} x + 2\ Wa\right)}{2\ W + y}}$

[NOTE.—The symbols F, W, R, and N have the same signification as in the example of the Buss governor described directly above. Q indicates the weight of sleeve + centre weight.]

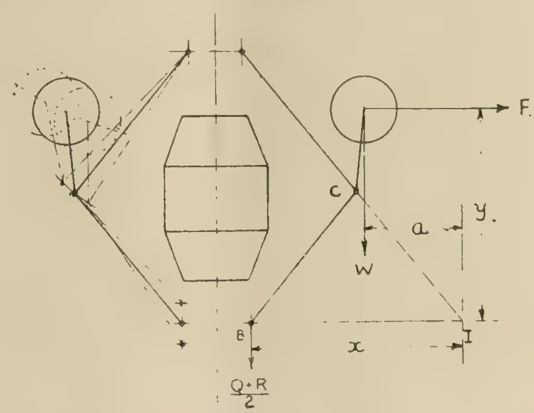


FIG. 25.—GOVERNORS.

Table 3 gives dimensions of some sizes of above governor.

The more modern form of Proëll governor has already been shown in Fig. 17. Referring to Fig. 26, which represents one side, the force P, acting

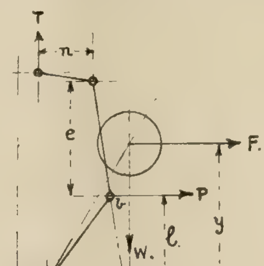


FIG. 26.—GOVERNORS.

horizontally at the joint b is composed of two elements—K due to the weight of half sleeve + friction S; and Q due to the half spring load T.

Then $\quad Sx = Wa + Kl \quad$ Therefore $K = \dfrac{Sx - Wa}{l}$

Also $\quad Tn = Qe \quad$ therefore $Q = \dfrac{Tn}{e} \quad$ and $P = K + Q$

$Pl = Fy \quad F = \dfrac{Pl}{y} \quad F = {\cdot}00034\ W + N^2 \quad N = \sqrt{2937 \dfrac{F}{Wr}}$

TABLE 3.—Proell Governors. (*See Fig.* 25.)

Total Lift of Governor.	R.P.M.	Weight of Governor Ball.	Centre Weight.	Radius to Centre of Governor Balls. Inches.		H. Inches.		Length of Link A.C.	Length of Link B.C.	P.	T.
Inches.	Normal.	Lbs.	Lbs.	In.	Out.	In.	Out.	Inches.	Inches.	Inches.	Inches.
$2\frac{1}{2}$	236	7·19	200	$7\frac{9}{16}$	$10\frac{1}{16}$	$17\frac{3}{4}$	$15\frac{1}{4}$	11	$10\frac{1}{4}$	$1\frac{5}{8}$	$2\frac{1}{8}$
3	219	11·45	300	$7\frac{15}{16}$	$11\frac{1}{16}$	$19\frac{7}{8}$	$16\frac{7}{8}$	$12\frac{1}{4}$	$11\frac{1}{4}$	$1\frac{7}{8}$	$2\frac{1}{2}$
$3\frac{1}{2}$	204	15·8	400	$9\frac{1}{8}$	$12\frac{3}{4}$	22	$18\frac{1}{2}$	$13\frac{1}{2}$	$12\frac{1}{2}$	2	$2\frac{3}{4}$

The Hartung Governor.

It will have been noticed from the description of all the foregoing governors that, with the sole exception of the crankshaft governor, shown in Figs. 7 and 8, the lever or link which transmits the motion of the balls to the sleeve, also transmits the controlling force to the balls; this causes friction, often excessive. In the Hartung governor, Fig. 27, the levers simply transmit motion. The weights AA are bored out to receive compression springs, the

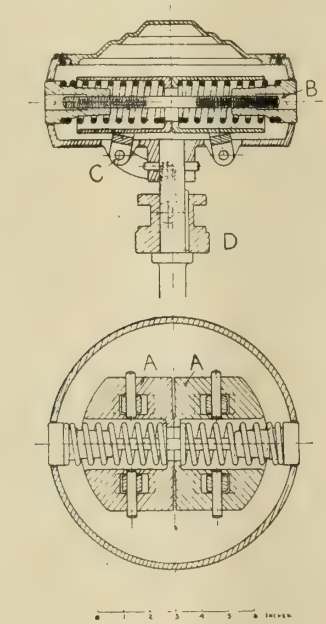


Fig. 27.—Governors.

tension on which can be adjusted by screw B. The bent levers CC are hinged to the weights at one end, and at the other end they are linked to sleeve D. The centrifugal force of each weight is taken by the direct compression of the spring. With this governor, friction is almost entirely eliminated and the number of working parts is a minimum. The springs and weights are enclosed in a circular case, which gives the governor a neat appearance, and at the same time acts as a guard against possible damage and injury should a breakage occur.

(To be continued.)

IRON AND STEEL INSTITUTE: PRESIDENTIAL ADDRESS.

By Eugene Schneider.

(Concluded from Vol. VI., page 468.)

It behoves us, therefore, to cast up the account of our resources in hydraulic power, so as to reserve for metallurgical purposes the greatest possible part of our coal production. Those resources may even now be easily appropriated for the traction of trains and tram cars, lighting purposes, and the distribution of driving force over extensive zones, since a 60,000^v voltage is in use, and one of 120,000^v will be so very soon. Whereas the waterfalls now utilised yield only from 700,000 to 800,000 H.P., future plants should allow a yield, at low water, of a minimum of 4,500,000 H.P. And as 1,000 hydraulic horse power economise per year 10,000 tons of coal, in round numbers, the profit to expect from those plants will rise to 30 million tons, that is to say, a figure approximating our total coal extraction before the war.

Metallurgical and mining industries are interested in this question not only indirectly in the way we have pointed out, but also directly, by the use of hydro-electric current to control engines and even to produce metal.

The engineer's task, as we conceive it, begins here in an endeavour to combine harmoniously the use of thermic power as produced by the blast-furnace and coke-ovens, and hydro-electric power; the latter having the defect of being transmitted by very long lines exposed to many risks. It will, therefore, be well to provide very powerful thermic generating sets, ready for running at a moment's notice, capable of carrying on the work in the chief departments, pending the time when the thermic emergency stations have brought up to a maximum figure their normal reduced power.

That part will devolve upon groups worked by Diesel motors of 2,000, 4,000 and even 6,000 H.P., the price of oil-fuel being, in that case, a negligible matter. We are studying in France such motors and their realisation seems assured.

Hydraulic power will, in certain cases, be directly utilised in our metallurgical works, without previous electric transformation. Workshops turning out projectiles have already been equipped with hydraulic presses worked directly

by water forced at high pressure through pipes. More powerful presses may be worked in a similar manner, and even rolling mills might be driven by high-pressure hydraulic turbines, transmitting their energy, in the case of reversible mill engines, through the medium of a Föttinger transformer. May I recall here that a similar installation was realised by us several years ago at the Terni steel works for the manufacture of armour-plates (the power-transformer being electric).

The electric blast-furnace is not yet widely used in industry, but the development of electric furnaces destined to the production and refining of steel is certainly assured, especially in works using hydro-electric current as motive power. It is likely that various combinations of the electric furnace with the Thomas converter or the basic open-hearth steel will in future be the characteristic feature of that special iron metallurgy which is the necessary consequence of a dual source of heat. It will be the topography of the region, or more exactly the place of the works on the "electric map" of France that will determine the proportionate demand to be made from either of the two sources.

Those are entirely new vistas opening up before our engineers. Nor should they, on that account, forget the questions of internal organisation, more immediate and more varied in their form.

The immediate improvements capable of realisation in a great number of ironworks must strike the unbiassed visitor. It is seldom, indeed, that there is a perfect equipoise between the productiveness of furnaces and the output of forging machinery, presses, or hammers. Still more seldom has the general topography of the workshop been attended to and the position of the various engines planned with a view of ensuring a rational transit of the products through the different stages of their manufacure. The result of that general defect of organisation is always an increase of what is conventionally termed "dead stops," which ought more rightly to be called "harmful stops," for the power of words is great. The mere change of words might perhaps wake every mind to the necessity of reacting against such deplorable losses of time, which it is easy to reduce without any new inventions, but by instituting a better discipline. I carried out the following experiment, destined to show the importance of "dead stops" in current forging operations.

Two compressed steel ingots, weighing respectively 21 tons, were selected, as they came from the moulds, to be forged into three 220 mm. Schneider mortars (8.6 in.) and one 155 mm. Schneider howitzer (6 in.).

Particular attention was bestowed on the former through all forging operations ; the latter was left to the current routine of the gunshop. Now, whereas it took eleven and a half days and seven heatings (plus one of annealing) to transform the former, for the latter forty-three days and nine successive heatings (plus one of annealing) were necessary. The expenditure in fuel was, therefore, more considerable for the latter ; but especially there was ample scope for "dead stops."

Thus in dealing with most industrial problems we are brought back to an examination of what will constitute a good organisation even before making research in scientific improvement. Such research must be undertaken only when once "our house is in order"—that is to say, when the adopted organisation sets each thing in its place and leaves the responsible heads with sufficient freedom of mind to devote a part of their time to technical questions. Lastly, the scientific research destined to improve the industrial technique is, it seems to me, of a rather special order, and, at any rate, notably different from research such as practised by the scientists and professors of our great scientific institutions.

Some say pure science is disinterested, or, in other words, indifferent to results ; that its goal is the truth, the pure, the simple naked truth, and that it is pursued for the pleasure of the pursuit ; like a sportsman who enjoys the pleasure of a day's shooting but who is indifferent to the game he bags.

This is perhaps exaggerated. At any rate, the aims of the metallurgist are more practical ; he too aims at scientific truth, but a truth which can be applied to some useful end ; he is not like the pure scientist, all indifferent to the game he bags. I am convinced, also, that in no other branch of industry can the union of empirical knowledge and scientific research be attended with better results than in that of metallurgy.

The opinion is no doubt excessive. For my part, I am inclined to think—and I believe I have shown you on what facts my opinion is grounded—that our metallurgical industrialists can derive much profit from scientific research, on condition that the questions are stated and treated in the proper manner—that is to say, in taking into account the results already attained, regardless of their origin, however empirical it may be, and, above all, in limiting the field of research to the immediately realisable object in view.

It was certainly to suggestions such as those that I have just outlined that the foundation of the National Physical Laboratory was due, and we cannot help wishing that this magnificent institution may completely fulfil the purpose that seems to be at the basis of all general progress in contemporary industry, and, above all, in metallurgy—namely, to establish and maintain a harmonious balance between the efforts devoted to disinterested general scientific research on the one hand and those spent in the pursuit of immediately utilisable results in the vast and varied provinces of technology.

It is certain that this balance is a function of the particular genius of each nation, and that, even if an organisation similar to the National Physical Laboratory was founded in my country, the part played by that institution in our industrial and technical development would be quite different from that which it plays in Great Britain.

Whereas, indeed, our French engineers and scientists are still imbued with the classical bias obtaining of old among us, and always seek to realise their scientific ideal by setting up doctrines of unexceptionable symmetry in accordance with the strictest rules of Cartesian logic, the British engineers and scientists, having outgrown that too rigid and geometrical discipline, more often obey the call of their independent imagination. The results thus attained constitute a vast province extremely varied in aspect, but it is plain that it is more than ever indispensable to sacrifice a litle of the picturesque, and to set

bounds to that splendid riot of individual enterprise, not with a view of marshalling individual minds in due order according to the German methods of work, then stripping them of all spontaneity, but only to realise a unity of purpose necessary to their right use and quite consistent with the free play of each mind.

With regard to us French people, we must guard, not so much against the excesses of our scientific imagination, as against our exaggerated love of generalisation and of what we call "pure science," to which we are always tempted to give up the seat of honour even at the cost of neglecting a little too much technological researches which are, after all, those alone whose results are of immediate benefit.

I am afraid that I shall appear most exacting to our younger engineers, fresh from college, and fired with enthusiasm for the "scientific sport" that they have practised for many terms, and even more so, no doubt, to older scientists inured to disinterested research. But I am convinced that I am in the right, and I should be most happy to bring some of you to share my opinion, for a close collaboration of scientists and metallurgists on both sides of the Channel is certainly one of the chief factors in the rapid restoration of the balance of the world so gravely disturbed during the last years by the folly of German Imperialism.

(Concluded.)

ECONOMIES IN THE GENERATION AND USE OF STEAM.

By Sidney F. Walker, R.N., M.I.E.E., M.I.M.E.

(Continued from Vol. VI., page 368.)

Advantages of High Vacua in the Condenser.

It was mentioned in the previous article, that the principal advantage of condensing the exhaust steam was the utilisation of a wider range of temperature, according to the well-known law governing all heat engines. The advantage will be seen more clearly when it is mentioned that with a vacuum of only 25 in. in the condenser, an additional 40 B.Th.U. per lb. of steam are usefully employed above those that can be used when exhausting to the atmosphere at, say, 5 lb. gauge pressure; and with a vacuum of 29 in. a further 26 units are brought into service; while with an initial steam pressure of 160 lb. per square inch, only 41 B.Th.U. are utilised when exhausting to the atmosphere, and only 47 units with an an initial gauge pressure of 250 lb. per square inch when exhausting to the atmosphere.

The matter may be looked at in another way; taking an initial gauge pressure of 50 lb. per square inch, and a cut off at $\frac{1}{8}$ of the stroke, the mean pressure behind the piston is approximately 25 lb. absolute per square inch; if the engine is exhausting to the atmosphere, a mean back pressure of at least 16 lb. has to be subtracted from the mean pressure behind the piston, leaving a mean effective pressure of only 11 lb. per square inch, while with a vacuum of 29 in., the mean back pressure may be as low as 2 lb., leaving a mean effective pressure of 25 lb.

An Economical Conversion.

The Wheeler Condenser Company report an instance where a simple non-condensing engine was consuming 46.8 lb. per indicated horse power, which was converted to a compound condensing engine, and with the same initial boiler pressure consumed only 16.6 lb. per indicated horse power. A little consideration will show that the addition of a condenser to an engine, whether it is a simple engine, compound, or triple expansion, will add to the output or alternatively reduce the consumption of coal for the same power delivered by the crank shaft. There have been numerous cases where a works has grown up in a town, in a confined space, and more power having been required to provide for the increased number of machines to be driven; while there has been no space for additional boilers, or larger engines; the trouble has been met by increasing the steam pressure, and fixing a condenser. It will be understood, of course, that some of the older types of engines cannot be employed with higher steam pressures, but they can nearly always be made to run condensing the exhaust steam, in place of delivering it wastefully to the atmosphere. With low-pressure engines, applying a condenser with even a comparatively low vacuum would increase the power delivered very considerably. If we take the case of an engine and boiler, working with an initial gauge pressure of 50 lb. per square inch, when exhausting to the atmosphere, approximately only 36 B.Th.U. are utilised, while with a vacuum of only 25 in. a further 40 units are available.

Another Notable Point.

With the steam turbine the difference between exhausting to the atmosphere and into a condenser are even more marked; and it is only since steam turbine engineers demanded higher and higher vacua that the steam condenser has really reached the high efficiency with which we are now familiar. Previously to the advent of the steam turbine, it was a canon of the steam engineer's faith that it was not economical to run condensers with a higher vacuum than 25 in., and he was quite correct as condensers were then made, because the higher vacua cost more in coal to provide the power to pump the additional circulating water required than was saved by the higher range of useful heat obtained, and the longer range of useful pressure. Just before the steam turbine became a practical apparatus—it had been known as a steam eater in its earlier form—a very able steam engineer, who had specialised in condensing plant, carried out a long series of experiments, with very careful measurements, to determine the actual working conditions, how far it was economical to carry the vacuum under different conditions, with cooling water of different temperatures. He found that up to vacuum of 25 in., other conditions being the same, the coal consumption per indicated horse power per hour, and the steam consumption, steadily decreased; after what was then the limiting vacuum was passed, the figures began to increase, and the reason was the inches of vacuum above 25 in. required steadily increasing quantities of cooling water to obtain them, and so the cost of pumping the water steadily increased.

So strongly was this faith held by steam engineers that, with steamships running through the tropics, say, from the United Kingdom to South America, or the Cape, and even in those running into subtropical waters, very little attempt was made to obtain more than 20 in. when the

temperature of the sea water rose appreciably above 60 deg. Fah. Now that is all changed, condenser makers have responded to the demand of the steam turbine engineers, and at the present day, vacua of 28½ in. are quite common, and 27½ in. has become practically the standard for reciprocating engines; it is obtained under what may be termed very ordinary conditions, say, with compound and triple-expansion engines having a convenient supply of water that does not cost much in pumping. The writer has in view two typical cases, one that of the electricity generating station in a large town in the North of England, situated at a considerable height above the river on the banks of which the town stands. Circulating water for the condenser is taken from the river by means of a centrifugal pump and is returned to the river again through a water turbine; the pump and the turbine are both connected to an electric motor, the three axles being in one; the motor has only to provide the difference in power between that required to lift the water from the river and that returned to the system by the descending water from the condenser, and to overcome the friction of the pipes. In the other case, there is a small generating station supplying a small town in Wales, and standing a little above a canal, from which the circulating water for the condenser is obtained. In this case, the water is simply syphoned through the condenser, a pump requiring only small power being placed in one leg of the syphon to overcome the friction.

(*To be continued*).

Publications.

Engineers are at times called upon to lay down electrical plant for a specified purpose. Too much care cannot be bestowed in this direction, and a perusal of the abridged catalogue issued by **Messrs. George Ellison,** of Perry Bar, Birmingham, will perhaps be helpful to those in doubt. This firm is rapidly progressing in the manufacture of automatic circuit-breakers for alternating-current and direct-current circuits up to 750 volts, motor starter and control gear, oil break switches, limit switches, and crane gear. A notable feature is the special care that has been given to the perfection of alternating-current apparatus, and attention is called to the "Ellison Relay Type Crane Panel," a diagram of connections of which appears on page 76. A very useful little booklet is issued, entitled "Hints on Rectifying Faults in Motor Control Gear," giving some information regarding the maintenance of their apparatus. This is in a number of cases also applicable to other makes of control gear. On the last four pages of this booklet are given the full load currents for direct-current, single, two, and three-phase motors on various voltages.

Messrs. Broom and Wade, of High Wycombe, have published a very interesting brochure (No. 11) in connection with the construction of the "Hyatt," roller bearings appertaining to cranes, trucks, and general transporter appliances. According to recent tests, it is claimed that from 30 to 70 per cent of power is saved by the application of a correctly constructed roller-bearing. The design is certainly unique, the rollers being hollow and flexible, and made from a flat strip and wound helically, being afterwards ground to within very fine limits. This imparts a flexibility permitting the rollers to conform to any slight irregularities in the adjacent parts. The bearings are provided with a steel outer race; also an inner race may be had if the shaft is not hard enough to take the wear. Some interesting figures are given on pages 8 and 9 regarding the loading capacity per bearing for a given size of shaft. The construction of these bearings, and the various purposes to which they can be adapted are well illustrated, and those interested in any special requirements should communicate with this firm.

Owing, perhaps, to the serious outlook of the fuel question, boiler feed water temperatures have never received so much attention as at present. **Messrs. Holden and Brooke,** West Gorton, Manchester, are manufacturing exhaust steam feed water heaters on their patent "high-velocity system," in which they claim that feed water is delivered fully 20 degs. hotter by this process than by ordinary heaters. From tests made, water temperatures as high as 207½ degs. Fah. are readily obtained, and at maximum capacity temperatures up to 206 degs. Fah. are guaranteed with exhaust steam at atmospheric pressure, without setting up any back-pressure in the engine. Their list No. 277 is well illustrated, and provides much useful information concerning the construction and capacities of this apparatus. The firm is also engaged in the manufacture of several appliances appertaining to the economical operation of steam plant, notable amongst which is the "Sirius" patent expansion steam trap, and the "Brookes" patent hot-water injector, which is operated entirely by one handle.

The supply of light and power to isolated places is at times a difficult problem. A remarkably well illustrated brochure is issued by the **Keighley Gas and Oil Engine Co. Ltd.,** of Imperial Works, Keighley, who are making, in addition to their horizontal engines, a very compact little vertical engine. These are made either tank or fan-cooled with radiator, and have four, two, or single cylinders, according to output. They are designed to run either on petrol or town's gas, and are coupled to small direct-current generators, or, as an alternative, fitted with an end bearing and pulley. These direct-coupled sets vary in size from 3½ kw. to 30 kw., and, if desired, the smaller units can be purchased with switchboards attached, making them specially adapted to country house lighting. These machines are used for a number of purposes, and are most convenient where floor space and speedy erection have to be considered. Some useful figures are given regarding the relative consumption of petrol to town's gas per brake horse-power per hour. The firm also specialise in portable sets for use on farms and estates for pumping, chaff cutting, etc.

The hardening and tempering of steel requires the exercise of the greatest care. There is frequently a considerable range over which reasonably good results are obtained; when, however, the correct treatment is attained, the efficiency may be increased enormously. **Messrs. John Wright and Co.,** Essex Works, Aston, Birmingham, have issued an interesting pamphlet on the "use of liquids" (consisting of fused salts and mixtures of salts) for the heating, quenching, and tempering of carbon and high-speed steel. Various processes are described, one advantage over the lead bath being that the articles do not tend to float. Consequently a more uniform heat is obtained. Illustrations of hardening, tempering, and quenching baths are shown, and a special bath, rectangular in shape, is made up to 20 ft. in length for the successful treatment of bars. The firm have had 20 years' experience in the use of fused salts and temperature-measuring instruments in connection with the treatment of steel.

The brass industry is making great efforts to reorganise itself on up-to-date lines. We have recently received a second edition of a pamphlet offering a complete scheme of syndication which **Mr. Howard F. Smith** (a member of one of the Birmingham firms—Smith and Davis Ltd., Birmingham—) has re-published. A considerable amount of additional matter is given, which will be read with interest by all those who are earnestly looking forward to the post-war conditions of this industry. That the scheme is meeting with favour is evidenced by the number of extracts from appreciative letters received from members of the industry, which are reproduced in the pamphlet, whilst the comments and criticisms from the trade and technical press and the number of interesting questions to which Mr. Smith supplies his answers can be read with profit by those concerned, bringing together, as they do, the many shades of opinion that exist in connection with an enterprise of this kind.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.

Manchester Branch.—Altrincham Sub-Branch.

Will all branch secretaries please not that Mr. W. G. Murphy, 2, Harcourt Road, Altrincham, has been elected district secretary for the above branch. All future communications to be sent to the above address.

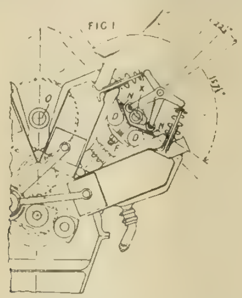
Patent Applications.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

ABSTRACTS OF SPECIFICATIONS.

INTERNAL-COMBUSTION ENGINES.

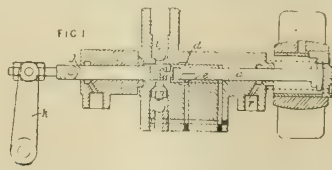
116,124.—W. F. Hooper, Crooksbury, Oak Grove, Anerley, and A. J. Westlake, 20, Clifton Gardens, Maida Vale, both in London.—May 25th 1917.—In an engine having inclined cyliders which may be arranged in four or six parallel planes with four cylinders in each plane the valves are actuated by a pair of cam



shafts X mounted upon **Y**-brackets N secured by plates F to the induction pipes D. The ends of the valve levers adjacent the cams are inclined to one another at an angle equal to one-half the angle between the corresponding cylinder axes. The **Y**-brackets may bear upon the cylinder heads. A propeller shaft is shown at O.

RECIPROCATING PUMPS.

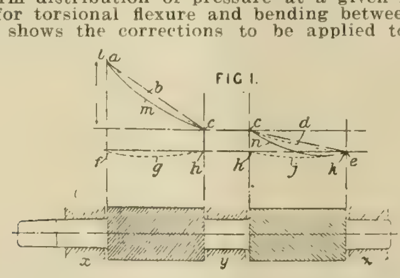
116,132.—E. Gardner, Barton Hall Engine Works, Patricroft, Lancashire.—May 26th, 1917.—A fuel pump for internal-combustion engines comprises a movable cylinder *d* connected by a rod *j* and arm *k* to the governor and provided with a by-pass port *e* through which the liquid is forced during the delivery stroke until the piston *a*



covers it. The areas of the inner and outer end surfaces of the rod *j* and cylinder *d* are so chosen that the liquid pressure in the pump does not produce thrust on the governor. In a modification, the liquid is delivered through the delivery valve *i* until a passage in the piston registers with the port *e*.

TOOTHED GEARING.

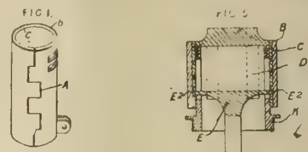
116,147.—Sir C. H. Parsons, Heaton Works, Newcastle-on-Tyne, and S. S. Cook, Turbinia Works, Wallsend-on-Tyne.—May 31st, 1917.—Toothed wheels and pinions for high-speed helical reduction gearing, etc., are provided with teeth of such a form as to give a uniform distribution of pressure at a given load and to compensate for torsional flexure and bending between the bearings. Fig. 1 shows the corrections to be applied to the tooth-



form of two pinions to which torque is transmitted from the end *x*. The curves *a*, *b*, *c* and *c*, *d*, *e* represent the torsional flexure, and the curves *f*, *g*, *h* and *h*, *j*, *k* the bending between the bearings *x*, *y*, *z*. The sum of the deflections is represented by the curves *l*, *m*, *c* and *c*, *n*, *e*, an approximation to which is obtained by two inclined straight lines. In cutting the teeth, the slide on which the tooth-generating hob moves is inclined at the required angle so that the radial penetration of the hob increases across the face of the gear blank, the greatest penetration being at the end at which the torque is applied. The correction may be made on either or both wheels which gear together.

SLIDE, ETC., VALVES.

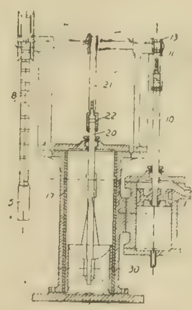
116,170.—C. F. Ryland, 109, St. Michael's Road, Aldershot.—June 16th, 1917.—A rotary or reciprocating sleeve valve for internal-combustion or other engines is made of two metals of different expansibility, such as brass and steel, so that its diameter remains the same at different temperatures, or to provide for expansion or contraction with temperature changes to maintain a close fit. The valve shown in Fig. 1 consists of sleeves of steel B and brass C riveted together and divided at A. The sleeves may be arranged so that the two slots do not coincide. The valve may be connected to an internal actuating-piston. Fig. 5



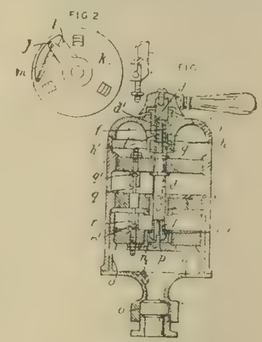
shows an arrangement in which the valve B, C works over a fitting K ported at D and screwed into a poppet-valve seating. The valve is reciprocated by a cam-actuated piston E formed with projections E2 extending through slots in the fitting to engage the valve. The invention is applied also to a semi-rotary valve working in a cylinder head.

VALVES.

116,171.—R. St. G. Moore, 5, Victoria Street, Westminster.—June 19th, 1917.—A valve device arranged to maintain a constant flow of liquid supplied under a varying head, and particularly applicable for controlling the supply to filter beds, comprises a piston-actuated valve so loaded that the load automatically increases as the valve is moved towards its closed position. The valve member consists of a sleeve 30, adapted to move in an interchangeable ported liner 17. The valve spindle 20 is adjustably connected by a coupling 22 and strap 21 to a pulley on a shaft 31, which also carries a pulley 13 adjustably connected by a strap 11 to the rod 10 of a piston 1 subject to inlet pressure admitted through a port 2. The shaft 31 also carries a member having a contour similar to a snail cam and to which the load is applied by a spring or weight 5 acting through a flat chain 8. The apparatus can be used for controlling the supply to one or more filter-beds provided with overflow weirs; in the latter case the valve discharges into a stilling-box having a number of discharge weirs corresponding to the number to be supplied.



Patent 116,171.



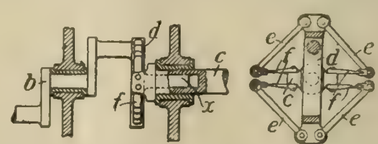
Patent 116,734.

ELECTRIC SWITCHES AND COUPLINGS.

116,734.—F. C. Stockel, 9, Manor Place, Paddington, London, and Fyfe, Wilson & Co., 155a, St. Vincent Street, Glasgow.—May 16th, 1917.—A quick-action switch is interlocked with a contact-carrying plug so that with the plug out, the switch cannot be closed, the insertion of the plug releasing the lock; the switch when closed locks the plug in position. The switch handle is carried by a hollow shaft *d* in which is placed a spindle *f*, having a cross-pin *h* working in a slot *g* in the shaft. A spring *i* presses the spindle down, so that the cross-pin enters a slot *h*1 in the cover *c* and prevents turning of the switch handle until the spindle is raised by the insertion of the plug *o*, a projection *p* coming against the bottom of the spindle. The shaft *d* having a bayonet-slot connection *n*, *o*4, which holds the plug in place when the shaft is turned. The switch mechanism comprises an arm *j* keyed on the shaft and connected to a rotatable disc *k* by a spring *m*, Fig. 2. The disc carries switch blades *q*, *r* co-acting with contacts *q*1, *r*1 on the casing and on the plug. The arm *j* has limited movement in a recess *l* in disc *k*; with the switch closed, the arm *l* is turned to strain the spring which then opens the contacts with a quick movement. A gland *d*1 is used where the shaft *d* passes through the cover. Stops on the cover limit the movement of the handle.

CRANK-SHAFTS.

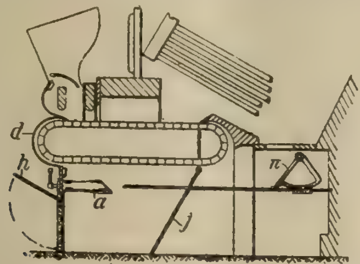
116,820.—A. Riedler, 7, Rauchstrasse, Berlin.—Sept. 26th, 1917. In flexible means for driving a shaft *c* from an engine-driven crank-shaft *b*, plate springs *f*, Fig. 1, secured to projections on the shaft *c* bear against opposite sides of the crank web *d*, or



spring arms *f*, Fig. 3, secured to the projections are connected by links *e* to the web. Helical springs abutting against stops on the projections and web may form the resilient connection. The end journal *x* of the crank-shaft rotates freely within the shaft *c*.

FURNACES.

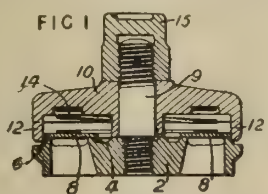
116,750.—S. J. ROSS and H. SCHOFIELD, 117, Leadenhall Street, London.—June 16th, 1917.—In a forced-draught arrangement for a travelling grate, an air-tight casing *d* extends round the front of the grate and is provided with one or more air-tight flaps or doors



h for closing in front of the ash-pit, one or more air-induction pipes or nozzles *a*, forming injectors, being arranged below the grate. As shown, the injectors are mounted on the front casing above the doors, but they may be mounted on the side plates of grate frame. A hinged flap or deflector *j* is preferably mounted at the rear of the ach-pit, and a clinker-discharging door *n* is provided. The injectors preferably have their discharge ends bevelled as shown to give an upward direction to the blast.

VALVES.

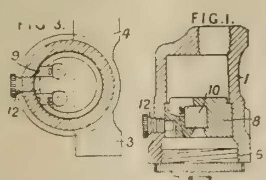
116,756.—H. S. BROOM and BROOM AND WADE, High Wycombe, Buckinghamshire.—June 20th, 1917.—A non-return valve for air-compressors, etc., comprises an annular disc 8, a seating 2 formed with stops or ledges 4, 6, and a guard 10 provided with down-



wardly-extending fingers 12 which enclose and guide the volve disc. The seat and guard are secured together by a central bolt 9 and nut 15, as shown. A flat helical spring 14 rests in a channel in the guard and presses upon the back of the valve. More than one spring may be used.

ELECTRIC COUPLINGS.

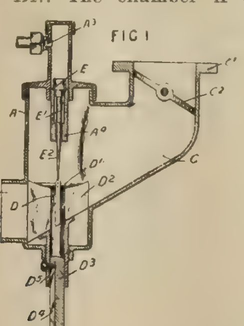
116,764.—ST. HELENS CABLE AND RUBBER CO., Warrington, and J. C. WHITE, 16, Westgate, Hale, Cheshire.—June 25th, 1917.—A terminal socket for lamp-holders, wall plugs, etc., comprises a casing 1 having a bridge-piece 8 of ebonite, etc., which is



moulded about the terminal connection 10 and is provided with cut-away portions or depressions terminating in grooves 9 to carry away any condensation moisture, etc. from the line wires. The bridge is held in position by a screw 12; and the casing is provided with ears 3, 4, by which it is secured to a wall etc., and with a screwed extremity 6 for receiving a cap 7.

INTERNAL-COMBUSTION ENGINES.

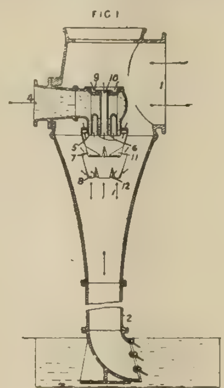
116,760.—H. HODKINSON, 20, St. Hubert's Street, Great Harwood, Lancashire.—June 21st, 1917.—The chamber A of a spray car-



burettor is provided with an air inlet B, and a mixture outlet C1 controlled by a throttle valve C2. Located in the path of the air current is a suction-actuated vertically sliding member D comprising a stem D3, prevented from rotating by a screw D5 and slot D4, and carrying radial webs D2 and a dished top D1 the periphery of which extends nearly to the wall of the air passage and above the bottom of the upwardly-sloping outlet chamber C. The member D actuates a fuel valve E, the stem of which comprises a parallel portion E1 and tapered portion E2 working in a guide A4. Fuel is admitted at A3, and any excess not immediately sprayed is collected in the cavity D1. The top D1 may be perforated, in which case an additional valve is placed in the air inlet B. The fuel valve may be loaded by a light spring.

EJECTOR-CONDENSERS.

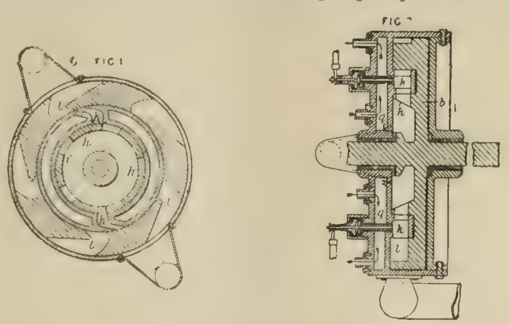
116,769.—J. TINSLEY, Beaufort, Breconshire.—June 26th, 1917.—Ejector-condensers or ejectors for withdrawing gases or vapours, of the type described in specifications 6612/03, 5812/04, and 22780/06, are provided with concentric alternating annular or polygonal water or steam, etc., nozzles 5, 9, 6, 10, and are fitted with guides



for the steam etc., in the form of cones or cylinders 7, 8 having serrated lower edges and triangular depressions or flutings 11, 12 in their surfaces. The steam enters by the passage 1 and the water by the passage 4, and the water of condensation seals the lower end of the vertical pipe 2 against the entrance of atmospheric air.

TURBINES.

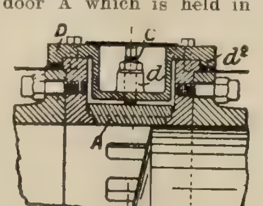
116,770.—D. C. BOLTON, Light Oaks, Oakamoor, North Staffordshire.—June 26th, 1917.—In an internal-combustion turbine, combustion chambers *k* formed in a ring projecting integrally from the stator co-operate on their inner periphery with a rotary admission valve *h* and on their outer periphery with buckets *l*,



both the valve *h* and the buckets *l* being integral projections of the rotor *b*. The compressed mixture is supplied to the valve *h* through a chamber *f*. Additional rings of stator guide-passages and rotor reaction passages may be provided; the additional rotors may be caused to rotate at a higher speed by epicyclic gearing, etc. A water jacket *q* may be provided.

STEAM ENGINES.

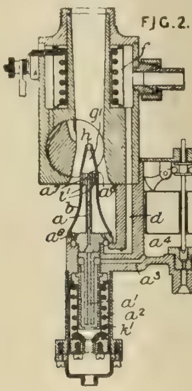
116,799.—GALLOWAYS LTD., Knott Mill Iron Works, Manchester, and H. PILLING, Glenderwyn, Manchester Road, Chorlton-cum-Hardy, both in Lancashire.—July 30th, 1917.—In a steam-engine of the uniflow type, an inspection opening formed in the exhaust belt is closed by a door A which is held in position by screws



C tapped into bosses *d* on a cover D secured to the exhaust belt by studs. The cover may be formed with overhanging flanges *d*2 in order to support the exhaust belt in the neighbourhood of the opening. The packing-rings can be examined through the opening and the interior of the cylinder can be inspected by inserting a periscope or other optical instrument carrying a lamp.

INTERNAL-COMBUSTION ENGINES.

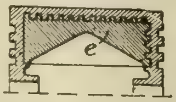
116,792.—W. R. PARKER, 164, Broad Street, Birmingham.—July 21st, 1917.—The fuel before issuing from the nozzle orifice of a spray carburettor is admixed with air preferably heated. The nozzle comprises an outer casing *b* and an inner tube *a* which is fed with fuel from the float chamber *a*4 through passages *a*3, *a*2, *a*1. The tube *a* is provided with an enlarged head *a*6 through transverse capillary passages *a*7 in which fuel issues into ducts *i*1 which are supplied with air heated preferably by an electrical heater *f* and passing to the casing *b* through passages *d*, *a*8. The heated air warms the fuel in the tube *a*. The mixed fuel and air pass into a chamber *g*1 and thence through the



usual discharge orifice *h* into the mixing chamber. The passages *i*1 may be formed by notches in the periphery of the head *a*6. In a modified construction, the air supplied to the casing *b* enters from below and is heated by the fuel-heating coil *k*1.

PISTONS.

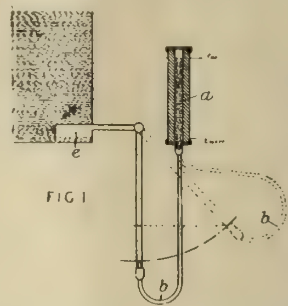
116,824.—A. RIEDLER, 7, Rauchstrasse, Berlin.—Sept. 28th, 1917.—In a piston for an internal-combustion engine, the cooling of the head is facilitated by the insertion inside the head of a body *e* which is a good conductor of heat and the cross-section of which



is as shown to facilitate the flow of heat. In order to promote the flow of heat, the surfaces of the body *e* and piston may be formed with engaging ribs and grooves. The piston skirt may be of cast iron and the head may be of the same material or of steel.

INDICATING LIQUID LEVELS.

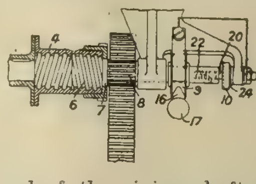
116,823.—G. H. ALEXANDER, 83, Coleshill Street, and R. J. NASH, 107, Bristol Road, both in Birmingham.—Sept. 27th, 1917.—To enable the same gauge tube *a* to be used with tanks of various depths, the tube is connected to the entrapped-air chamber *e* in



the tank by an adjustable **U**-tube *b* or the like containing liquid and acting as a seal. By inclining the **U**-tube, as shown in dotted lines, the full range of the gauge tube may be used to indicate the rise and fall of liquid in a tank of lesser depth. Instead of one arm of the **U**-tube being hinged as shown, it may be made of spiral tubing, which may be drawn out or contracted.

ENGINE TURNING-GEAR.

116,834.—G. GREEN, Pelham Villa, Strawberry Vale, Middlesex, and F. MAY, Thames Bank, Grove Park, Chiswick.—Nov. 6th, 1917.—In turning-gear for aircraft engines, etc., in which the starting-pinion is brought into gear with the engine shaft by means of a quick-pitch screw 6 and nut 4, a brake in the form of a metallic block 16 operated by a hand-lever 17 completes the circuit of the starting motor, and the circuit is maintained by a



contact 10 on the end of the pinion shaft 7 until the shaft is retracted by the starting of the engine. The brake 16 engages a **V**-section pulley 9 keyed to the pinion shaft by balls engaging in keyways in the shaft, and ensures the axial movement of the pinion 8 into gear when the motor is started. The end contact 10 is a cup-shaped member with a spigot 20 fitting in the recessed end of the shaft 7 and pushed out by a spring 22. It engages a fixed insulated contact 24 connected to the hand-lever.

INDEX TO ADVERTISERS.

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CONTENTS.

EDITORIAL.

THE ENGINEER AS AN INDUSTRIAL ORGANISER.

IN the absence of definite action on the part of the various engineering institutions, there seems to be the possibility that the engineer, as an organiser, will be overlooked in the critical years that are immediately ahead of us. Up to the present he has been to a large extent "cribbed, cabined, and confined," so far as his work has been concerned, with the result—the inevitable result, in our opinion—that his value to industry generally has never properly been secured and certainly not appreciated. It is going over very old ground indeed to refer to the manner in which the work and usefulness of the engineer have been limited in this country; how his recommendations have been turned down times without number, and he himself snubbed for his interference; how his remuneration has oftentimes been of such proportions as to make him heartily ashamed of it and of his profession; and even his capacity to handle large bodies of men denied him. Only too often has he been called in to approve of (in other words, to take the responsibility for) work undertaken by commercial men who were absolutely devoid of any knowledge of the technical problems involved, and hopelessly at sea as to the organisation which was necessary to its proper execution.

It has not been the case in this country, at all events to anything like the extent it should have been, that the engineer has been treated as a man not only possessed of certain specialised knowledge, but with a keen interest in all phases of the work with which his professional training and experience have brought him in contact. Here and there, of course, there have been exceptions, but, generally speaking, he has been kept outside the board-room when his place was really inside. It has been taken for granted—why, one cannot well understand, that he has a head for mechanical matters pure and simple, and that he knows nothing, and probably cares nothing, for commercial and industrial organisation

The trouble is that those who have been responsible for industrial enterprise have not themselves been practically acquainted even with the rudiments of an engineering training, but who have not for a single moment hesitated to define with minute exactness the duties of the engineer. As if that could be done, forsooth! in connection with modern industrial conditions. Instead of giving him a seat at the board or a responsible share in the general direction of affairs, they have taken upon themselves to settle problems quite outside their capabilities. Hence we had many of our industrial undertakings drifting perilously near the danger point when the war cut short their normal activities. Indeed, it is not too much to say that the majority of the labour troubles—to take only one phase of industry—of the last twenty years would have been more easily overcome, in many cases might have been prevented, if the engineer had been more frequently consulted and his advice acted upon. He has the unique advantage, not always given to leaders of industry, of knowing both the British workman and the work he is capable of doing.

We pride ourselves as a people on our broadmindedness and tolerance, but when it comes to industrial problems and to the calling in of the departmental heads or experts, our intolerance has

known no bounds. How often have we seen fine concerns being driven to the wall because the last word has been left to the financial magnate or perhaps to that individual better known as the company promoter, who cared nothing for the fortunes of the concern, and less for the expert assistance which he ought to have made use of, but did not. That is a state of affairs that must belong to the dead past if the nation is going to reap the fruits of the experience which is being bought at such a price. Industrial engineers must see to it that the technical and scientific side is elevated to its proper position so that we may get the best out of the trained men. Until we have a new generation it is, perhaps, too much to hope that we shall attain our ideal, but in the meantime we must see to it that industrial engineering comes into its own in the widest and fullest sense of the phrase.

In the new order of things we hope to find the industrial engineer at the council table of the big undertaking, whether it be Governmental, municipal, or private, not giving advice when he is called in for the specific purpose of doing so, but there by right to participate as and when he thinks fit in any discussion that may arise; indeed, to initiate discussion, since he will often see more readily than anyone else the trend of any particular policy or movement. He must of necessity be an organiser, as indeed he has frequently been when given the opportunity, and there is so much to be done in this direction that we sincerely hope that he will be given greater scope and freedom. Not for a moment would we seek to depreciate the great services which business men generally have rendered to the industries of this country in the way of raising capital and in the creation of markets, but there is no reason why the successful engineer should not have as sound business acumen as anyone, or who would be a whit less fitted to be an industrial organiser as any of our great captains of industry. We make this plea because we fear that in the great disturbance which inevitably takes place in the reorganisation of industry, the thousands of excellent men who have never had the chance to show what they could do may be overlooked. It is not true, although some people appear to think it is, that the good men come to the top and make their influence felt, in spite of all difficulties. They have never been given the opportunities, mainly because functions which ought to have been theirs by right were usurped in the past by pushful personalities with little to commend them beyond a glib tongue and a cunning brain. We want, for the benefit of the community, as a whole, to see industry so reorganised by men versed in industrial engineering that every industrial engineer is being made the fullest use of. They are there, ready and willing to tackle any industrial problem that may present itself, and are prepared to see it through because they are possessed of those never-failing British qualities—doggedness and thoroughness. "This war," said Mr. Lloyd George once, "is an engineer's war." To that we want to be able to add, when it comes, that the peace we have fought for will be "an engineers' peace." If it is, then we shall have an intelligent organisation and applications of such resources, natural and otherwise, which we may possess.

ENGINEERING INVESTIGATION IN BRAZIL.

The British Engineers' Association, as is well known to its members, is paying considerable attention to making preparations for developing the export business of the engineering industry, and part of its programme is the appointment of Commissioners in Overseas markets. Owing to the difficulties arising out of war conditions of making practical use of the work of Commissioners, the Council decided, in the first place, to investigate the most promising markets.

Intimation has been received by the Association from the Department of Overseas trade that the Treasury will contribute one-half of the cost of an investigation into the conditions of and prospects for the engineering industry in Brazil.

The name of the gentleman selected for this investigation will be announced very shortly. He will spend a short time in this country, interviewing the various District Committees of the Association, and will spend approximately 12 months in Brazil.

Now that this first investigation is settled, the Council of the Association hope to arrange for similar investigations in other countries.

Manufacturing engineers not members of the Association who desire to take advantage of the reports of the Investigator should communicate with the Secretary, The British Engineers' Association, 32, Victoria Street, London, S.W. 1.

IMPORTANT GERMAN AMALGAMATION.

In view of the arrangements made for the fusion of the Wittener Stahlroehrenwerke (Witten Steel Tube Works) with the Mannesmannroehren Werken, of Dusseldorf, the shareholders of the Witten Company are being requested to forward, by September 17th latest, all their shares and dividend warrants for 1917-1918 *et seq.* so that they can be exchanged for those of the Mannesmann concern. This could be done through several banks, but after September 17th only through the German Bank in Berlin. Any shares received after Nov. 30th will be declared null and void. The exchange will be effected upon the basis of one Mk. 1,000 share nominal per every Mk. 1,000 worth of Witten shares.

A German Scout Biplane.—A German Pfalz single-seater biplane is described in a report prepared by the Technical Department, Aircraft Production, Ministry of Munitions. The construction is light and the design clean, and care has been taken to keep the fuselage of very good stream-line shape. The machine was found to climb to 10,000 ft. in $17\frac{1}{2}$ min., and to 15,000 ft. in 41 min. 20 sec., the respective rates of climb being 360 ft. and 110 ft. per minute. The speed at 10,000 ft. was $102\frac{1}{2}$ miles an hour, and at 15,000 ft. $91\frac{1}{2}$ miles. The machine is reported to be stable laterally, but unstable directionally and longitudinally. It answers well to all the controls, but tends to turn to the left in flight. It is not tiring to fly, and is normally easy to land. The most novel feature is the fuselage, which is simply a light wooden framework, without any bracing, covered with two skins of three-ply wood arranged specially in different directions. The under-carriage is constructed of stream-lined steel tube, and the shock absorbers are of rubber, which is somewhat unusual in German aeroplanes at present. The wings and wing bracing are a copy of the Nieuport practice. The engine is a 160 H.P. Mercédès.

GOVERNORS AND GOVERNING MECHANISM.

By A. Houlson.

(Continued from page 14.)

The Pickering Governor.

Another well-known governor in which internal friction is reduced to a great extent is the Pickering, Fig. 28. The drawing shows one of the latest type, operating an equilibrium throttle valve, and fitted with a ball speed ranger R, which enables the attendant to regulate the speed of the engine while it is running. The spiral spring S is merely used for lifting the valve, and is not used in any sense for changing speed. The ball ranger does away with the necessity for adjusting-nuts on valve stems, spring speeders, etc. For instance, if it is desired to decrease the speed of the engine, it is necessary to screw in on the small handwheel H. This pushes the steel balls B through the channel in the ball ranger, and the balls press upward on the fixed spindle C. The reaction of the latter causes the ball ranger to move bodily downwards. As it is attached to the valve spindle, it places the valve in a lower position; thus admitting less steam to the engine. The small locknut L,

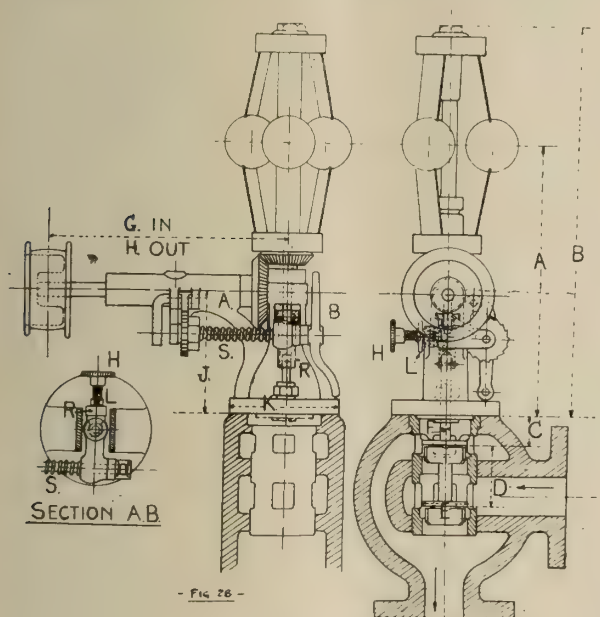


Fig. 28.—Governors.

which is readily turned by the fingers, secures the adjustment.

If, on the contrary, it is desired to increase the speed of the engine, one must screw out on the handwheel H, the balls in the ball ranger then fall back, and the tension spring S lifts the ball ranger, and with it the valve, thus admitting more steam to the engine.

It will be readily observed that the action of the Pickering governor mechanism is direct on the valve, rather than being conveyed through a series of joints, as in the case of governors previously described. This results in closer regulation, because immediate response is made for change in load, the throttle valve moving positively and quickly to the correct position for maintaining admission of steam proportional to the duty being performed by the engine.

The valve, being of the equilibrium type, the load on the governor due to steam pressure is almost entirely eliminated. The action of the governor is as follows:—

If an increase of speed takes place the balls fly out, and in so doing bend the leaf springs. These springs are fixed at the bottom, and when the balls move out-

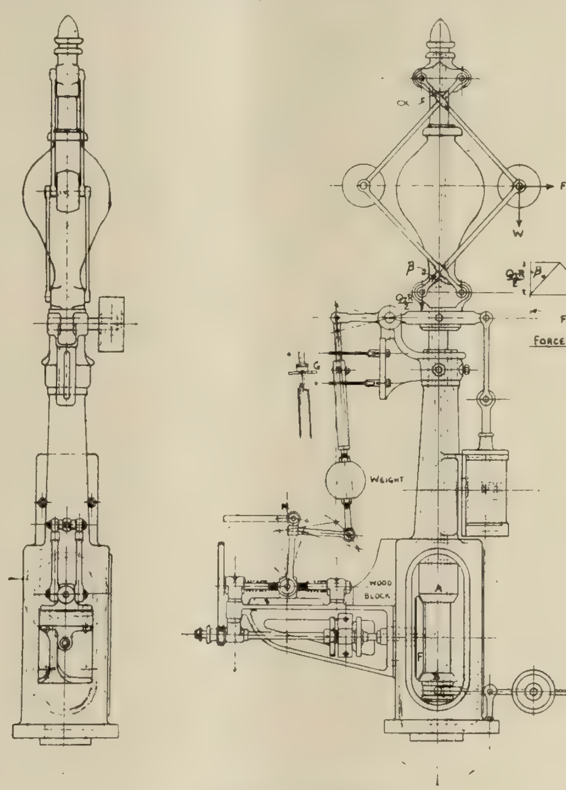


Fig. 29.—Governors.

wards the top cap is drawn down. A decrease of speed causes an opposite effect.

Three balls and springs are used to minimise the size for the same controlling force as compared with two balls. Table 4 gives dimensions of some Pickering governors.

Governors with Compensating Gear.

Up to the present, we have considered only those governors which directly control the steam supply, and which therefore will maintain the engine running on a heavy load at a speed below normal, and on a light load at a speed above normal. Governors with compensating gear have been introduced to remedy this defect, and one of this type is shown in Fig. 29. To the revolving vertical spindle are attached two friction wheels, A and B. Between these wheels is suspended another friction wheel F, with the smallest practicable clearance, so that, upon the slightest variation in speed, the upper or the lower wheel presses upon the wheel F, and rotates it in one direction or the other. The rotary motion is conveyed through simple reducing gear to a shaft carrying a sliding nut, which actuates the lever-carrying link M. The other end of link M is attached to the

TABLE 4.—Pickering Governors. *Dimensions in Inches.*

Size E.	Dia. of Balls.	Dia. Path of Centres of Balls.	Lift of Valve Total	Working Lift of Valve.	R.P.M.	Range of Speed. Total	Working Range of Speed	Controlling Force. Lbs.	Particulars of Spring.	Dia. and Width of Pulley.	A.	B.	C.	D.	F.	G.	H.	J.	K.
1 and $1\frac{1}{4}$	2	$3\frac{1}{2}$ to 5	$\frac{11}{16}$	$\frac{5}{32}$	350	87%	10%	·52	Total Thickness = 18 B.W.G. 3 Ply. $1\frac{1}{32}$ Wide. $5\frac{5}{8}$ Long.	$2\frac{1}{2}$ Dia. $1\frac{3}{4}$ Wide.	$10\frac{1}{16}$	$14\frac{1}{8}$	$1\frac{3}{16}$	2	$\frac{5}{16}$	$9\frac{1}{2}$	$5\frac{5}{8}$	$4\frac{5}{8}$	$3\frac{7}{8}$
$1\frac{1}{2}$	$2\frac{3}{8}$	$3\frac{7}{8}$ to $5\frac{7}{8}$	$\frac{11}{16}$	$\frac{13}{64}$	380	52%	10%	1·61	Total Thickness = 16 B.W.G. 5 Ply. $1\frac{1}{16}$ Wide. 8 Long.	$3\frac{1}{2}$ Dia. $1\frac{5}{8}$ Wide.	$12\frac{1}{32}$	$17\frac{1}{4}$	$1\frac{1}{4}$	$2\frac{1}{8}$	$\frac{3}{8}$	$10\frac{1}{2}$	$8\frac{1}{8}$	$5\frac{3}{8}$	$4\frac{7}{8}$
$1\frac{3}{4}$	$2\frac{3}{8}$	$3\frac{7}{8}$ to $5\frac{7}{8}$	$\frac{3}{4}$	—	380	—	10%	1·48	Total Thickness = 17 B.W.G. 3 Ply. $1\frac{3}{32}$ Wide. 8 Long.	$3\frac{1}{2}$ Dia. $1\frac{5}{8}$ Wide.	$12\frac{1}{32}$	$17\frac{1}{4}$	$1\frac{1}{4}$	$2\frac{3}{4}$	$\frac{3}{8}$	$10\frac{1}{2}$	$8\frac{1}{8}$	$5\frac{3}{8}$	$4\frac{7}{8}$
2	$2\frac{3}{8}$	$3\frac{7}{8}$ to $5\frac{7}{8}$	$\frac{13}{16}$	—	380	—	10%	1·36	Total Thickness = 17 B.W.G. 3 Ply. $1\frac{3}{32}$ Wide. 8 Long.	$3\frac{1}{2}$ Dia. $1\frac{5}{8}$ Wide.	$12\frac{1}{32}$	$17\frac{1}{4}$	$1\frac{3}{8}$	$2\frac{3}{4}$	$\frac{3}{8}$	$10\frac{1}{2}$	$8\frac{1}{8}$	$5\frac{3}{8}$	$4\frac{7}{8}$
$2\frac{1}{4}$	$2\frac{5}{8}$	$4\frac{5}{8}$ to $7\frac{1}{8}$	$\frac{7}{8}$	$\frac{7}{32}$	300	—	10%	1·6	Total Thickness = 16 B.W.G. 4 Ply. $1\frac{1}{4}$ Wide. 8 Long.	4 Dia. 2 Wide.	$13\frac{1}{8}$	$18\frac{1}{2}$	$1\frac{7}{16}$	$3\frac{1}{16}$	$\frac{3}{8}$	$12\frac{5}{8}$	$9\frac{3}{8}$	6	$5\frac{1}{2}$
3	$2\frac{7}{8}$	$4\frac{7}{8}$ to $7\frac{3}{8}$	1	—	340	—	10%	2·48	Total Thickness = 14 B.W.G. 4 Ply. $1\frac{1}{4}$ Wide. $9\frac{7}{8}$ Long.	4 Dia. 2 Wide.	$13\frac{1}{8}$	$19\frac{3}{4}$	2	$3\frac{1}{8}$	$\frac{3}{8}$	$14\frac{7}{8}$	$10\frac{3}{4}$	$7\frac{3}{8}$	$7\frac{1}{8}$

Velocity of Steam through Bush = 50 to 70 feet per second, corresponding to a velocity past cut-off edges of valve = 280 to 390 feet per second.

cut-off gear in such a manner that the lengthening or shortening of the link causes an earlier or later cut-off, giving just enough steam to drive the engine at the normal speed.

The governor in Fig. 29 is provided with two knock-offs, one for a high speed of the governor balls in the event of the engine racing, due to the load being suddenly thrown off; the other for low speed, in case of accident to the governor or the engine. In either case the action is as follows: The tappet G (see section) strikes the fixed stop, and thus releases the weighted ball W, which falls on to the wood block. This lengthens the link MM, and so shuts off the steam supply, thus bringing the engine to rest.

Another Form of Compensating Gear.

Another form of compensating gear is the mercurial regulator shown in Fig. 30. The regulator consists of a bracket carrying at its extremities two glass tubes containing mercury, these tubes connected by means of a small brass tube and cock. The regulator is fulcrumed at A, and is connected to the sleeve of the governor at B by means of a link A, B. Therefore, if the governor sleeve be depressed to its lowest position, as shown in Fig. 30, the left-hand mercury tube is depressed twice the amount, and consequently a portion of the mercury flows from the right-hand tube into the left-hand tube. This forms a virtual addition to the central weight.

The action of the regulator is exemplified as follows:—Suppose the engine is running at normal speed, and the governor balls are revolving in the normal plane of rotation, the height of the cone "h" being 9 in. Now, assume that an increase of load comes on the engine, causing the speed to drop. The governor balls will fall, and revolve in a lower plane of rotation, the conical height "h" becoming 10 in. Mercury will flow from the right-hand glass tube into the left-hand one, until the level of mercury is the same in both tubes, as shown in Fig. 30. The additional weight of mercury is now equal to 4 in. × cross-sectional area of tube × weight cubic inch of mercury; and this weight is equivalent to a downward force at the governor sleeve

$$= 4 \times \text{area} \times \text{density} \times \frac{20}{10} = 8 \times \text{area} \times \text{density} = x \text{ lbs.}$$

So that, if the weight of the central load and of the sleeve under normal conditions is L, then, when the sleeve is depressed to its lowest position, the downward force due to the weight of the sleeve and the central load is increased to L + x by the action of the mercurial regulator.

It will have been noticed that the action of this latter is correctly predetermined, the governor balls will revolve at the same revolutions per minute, although in a lower plane of rotation.

Because F, the centrifugal force,

$$= \frac{Wv^2}{gr} = \frac{r}{h}(W + L) \quad . \quad . \quad . \quad . \quad . \quad (1)$$

And as $u^2 = \frac{v^2}{r^2}$, then $\frac{v^2}{r} = u^2 r$

Substituting in (1),

$$F = \frac{Wu^2 r}{g} = \frac{r}{h}(W + L)\,;\ \frac{Wu^2}{g} = \frac{W + L}{h}\,;\ u^2 = \frac{g}{h}\left(\frac{W + L}{W}\right)$$

and u^2 must be constant.

If $L = 100$ and $W = 5$

then $\frac{g}{9}\left(\frac{105}{5}\right) = \frac{g}{10}\left(\frac{105 + x}{5}\right)$ and $x = 11{\cdot}67$ lbs.

It will have been noticed that the action of this latter device differs from the one previously described, in

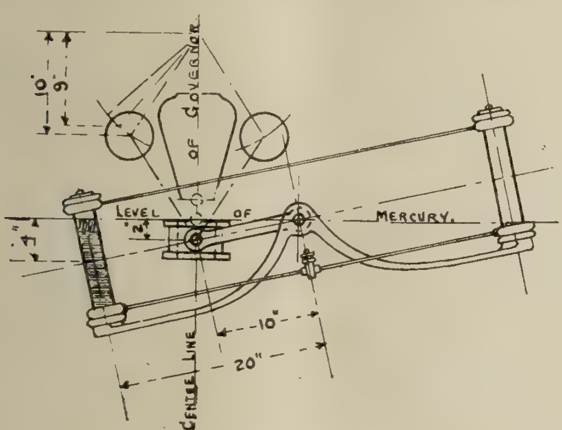


Fig. 30.—Governors.

that it allows the governor balls to remain in their lower position, whereas, in most compensating gears, the balls revolve in their normal plane of rotation, and the external agency regulates the steam supply to suit any permanent variation of load.

Relay governors are those whose function it is to

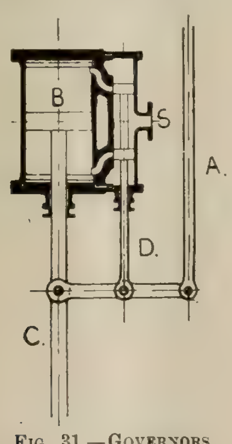


Fig. 31.—Governors.

operate some other agent which actually moves the steam supply valve. This construction does away to a great extent with external friction and the deviation from mean speed is very small. But there are two disadvantages, (1) the time lag between the governor and the agent, and (2) complication of parts. In order that a governor of this class should work without causing the engine to hunt, the piston and valve of the relay cylinder should be connected by what is termed differential gear, the effect of which is that for each displacement of the valve by the governor the piston moves through a distance proportional to the displacement of the valve. An example is shown in Fig. 31. Suppose that the rod A is connected with the governor so that it is raised by an acceleration of the speed of the engine. The rod C which leads from the relay piston B to the regulator serves as a fulcrum, and the valve rod D is consequently raised. This admits steam from the inlet S to the upper side of the piston, and depresses the piston, which pulls down D with it, since the end of A now serves as a fulcrum. Thus, by the downward movement of the piston the valve is again restored to its middle position, and the movement of the regulator then ceases until a new change of speed occurs.

(To be continued.)

RECENT TESTS OF CONCRETE COLUMNS.

Among the tests conducted recently by the United States Bureau of Standards as aids to the development of industrial methods were series relating to the construction of concrete columns and the production of insulating material.

Three tests were made of a special commercial insulating material to determine its pre-resisting properties. The material submitted by the manufacturers was intended for use in a number of instances to replace wood. The test specimens were about 18 in. by 18 in. and 6 in. thick. They were placed in a furnace as a panel, one of the larger faces being exposed to the heat of the furnace and the other to the atmosphere. Upon being heated to 950 deg. in 30 minutes and held at that temperature for four hours, it was found that the temperature at a distance of 1½ in. from the heat-exposed surface was about 240 deg. Cen. At a depth of 5½ in. from the heat-exposed surface 66 deg. was the highest temperature recorded. One of the blocks after having been subjected to this heat for the period mentioned was quenched with water. The damage to the specimen that was quenched was found to be less than to an unquenched specimen. This is explained by the fact that the blocks contained considerable organic matter, which tended to be disintegrated by the heat transmitted very slowly from the heated surface, even after the flame was removed from it.

The series of tests of concrete columns was partly in the nature of an investigation and partly in the nature of routine testing. These were the first columns of their kind to be tested in the United States. The unique feature is a hollow cast-iron core. This is surrounded by concrete, reinforced with both spiral and vertical reinforcing. Such a column may be made very cheaply. It would appear that the load which these columns can sustain is considerably in excess of that which can be borne by the ordinary reinforced concrete column of an equivalent cross-section.

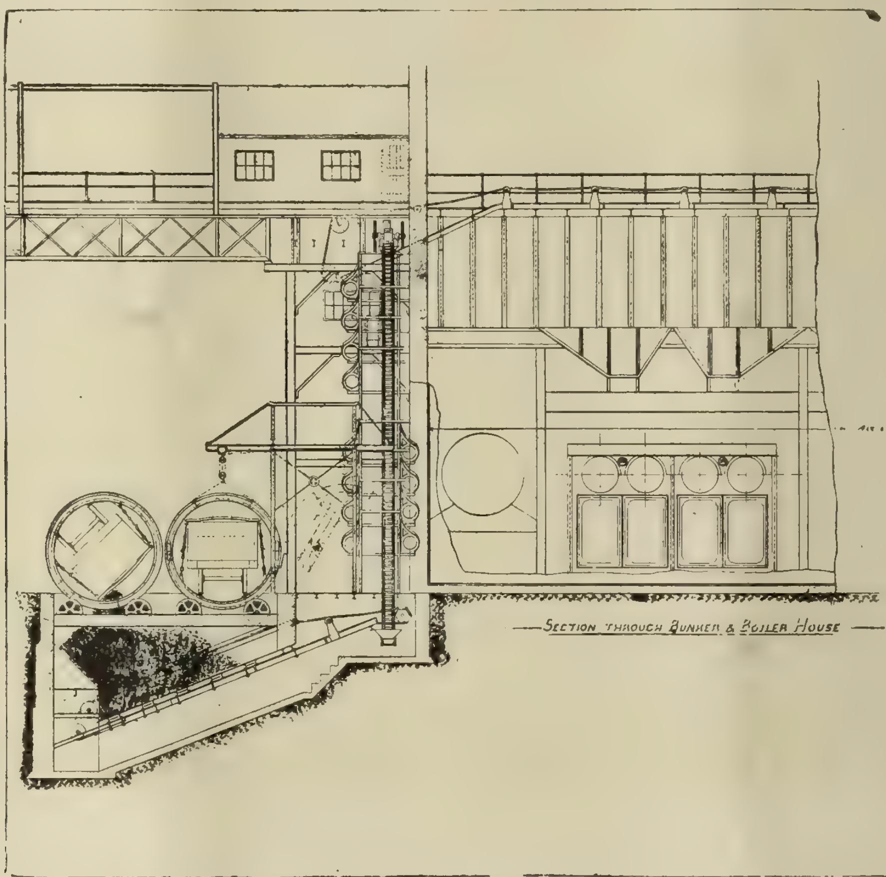
RAPID RAILWAY TRUCK DISCHARGE.

[Messrs. Ed. Bennis & Co. Ltd., 28, Victoria Street, Westminster, London, S.W.1]

Modern industrial processes involve the use of coal in extremely large quantities, and this will undoubtedly continue to be the case in an ever increasing degree for many years to come. Power is the largest item of expense in most manufacturing works and fuel represents about 70 per cent of its total cost. The cost of coal has, during recent years, been steadily rising in price, and there is every reason to anticipate that it will continue its upward tendency.

In these circumstances, economy in the use of coal is a matter not merely of self-interest, but of paramount importance in relation to industrial efficiency, as well as a solemn obligation to the national welfare.

More than ever before we now realise that industrial existence depends upon industrial efficiency, and if we are to maintain our primacy in industry it is essential that we should utilise to the fullest possible extent the resources of the country, especially in the avoidance of waste in the use of that essential, but not inexhaustible, raw material coal. The cost of coal, however, in its relationship to the total cost of power, must not be regarded merely as the price paid per ton delivered to the works. To this must be added the cost of labour and of time in handling until its final consumption in the furnace. In this latter respect there is still ample room for the introduction of modern machinery for effecting economies and increasing efficiency. One method by which marked economy can be obtained is by the installation of truck unloading plant. In this connection it may also be mentioned that an economic advantage of a reflex nature is thus secured, for the automatic discharge of railway trucks releases them for further use much more quickly than would otherwise be the case. The result of this is, in effect, to increase the carrying capacity of the railway by enabling a truck to perform two or three journeys instead of one. The extensive adoption of this system might conceivably lead to a reduction of freight charges, and consequently of the purchase price of the coal itself.



Rapid Railway Truck Discharge.

The first truck tippler ever built in this country for dealing with standard railway trucks was made by Ed. Bennis and Co. Ltd., for the Metropolitan Electric Supply Co's works at Acton Lane. It was installed in the year 1903, and after 15 years of active service, is still as good as ever, though many detail improvements have since been made.

The truck tippler at this station forms part of a complete coal handling equipment designed for handling small coal at the rate of from 60 to 80 tons per hour, and conveying it from the trucks to the boiler furnaces. In this system the loaded wagon, or coal truck, is turned over bodily, and its contents fall into a hopper built to receive it, and pass hence to a conveyor of the Bennis U-link type.

Opposite the boiler-house are two main lines of railway and a large coal bunker of 70 tons capacity has been built below the coaling lines. Immediately

over the top of this bunker are mounted two of the Bennis rotary side-truck tipplers, which enable the trucks to be completely turned over to be emptied. The tipplers are arranged so that the upper halves can be lifted off to allow a locomotive to pass through. The arrangement is clearly shown in the illustrations. The wagon is secured in the tippler by clamps which, when tightened up, hold it perfectly in place. The clamps are provided with a strong compensating mechanism to take up any shock. When the wagon has been secured, the attendant, by means of a switch, sets a five-horse-power electric motor in operation, which rotates the tippler containing the truck, the fuel being emptied into the receiving hopper, from which it is taken away by the conveyor. One specially interesting point to be noticed in the design of this tippler is that by its complete revolution it saves trimming, whilst emptying every ounce of coal. It rests on a series of rollers, one side being actuated by a reversible electric motor. Each tippler is capable of emptying 100 tons of coal per hour.

Rapid Railway Truck Discharge.

Another point worthy of notice is that the tippler rings are so proportioned that their centres nearly coincide with the centre of gravity of the truck in end elevation. The advantage of this will be obvious, the power being required to work the tippler being very little more than is sufficient to overcome the friction in turning.

The system of conveying may be described as consisting of a series of chains in troughs cast of special hard cast iron. The bottom of the trough is $\frac{5}{8}$ in. thick, and the side $\frac{1}{2}$ in. thick. The cross conveyor is 38 ft. long, and is placed immediately beneath the bottom of the bunker which receives the coal.

The coal passes to this cross conveyor through shoots with adjustable cut-off slides, and, after being partly elevated, is delivered on to the main inclined elevator-conveyor, which is 106 ft. long. This runs at an angle of 30 deg., and raises its load through a height of 40 ft. The fuel is then delivered on to the main distributing conveyor, which runs the full length of the overhead storage bunkers. The bottom of the distributing conveyor is fitted with openings and cut-off slides at intervals of 3 ft., by which means the fuel can be delivered at any of the bunkers above the boilers. The length of this latter, with its extension, is 395 ft. Each section of the conveyor system is driven by means of a separate motor through substantial spur-wheel reduction gear.

A somewhat similar plant, though on a much larger scale, is that recently erected to the order of H.M. Government.

In this case the plant serves a range of 32 Lancashire boilers, each fitted with "Bennis" mechanical stokers and compressed air furnaces. Storage is provided for about 2,240 tons of coal, and the coal is transferred from the railway trucks to the storage bunkers at the rate of 60 tons per hour, and the plant is capable of transferring the coal from the bunkers to the stokers at the rate of one ton per boiler per hour.

The full railway trucks are pushed by the locomotive into a "Bennis" patent rotary truck tippler, which, as in the previous case, revolves through a complete circle, so that the trucks are turned upside

down and completely emptied without raking or trimming. The clamping gear which holds the trucks in position is adjustable, so that the tippler can take any height of truck up to the maximum size for which it is designed.

The tippler revolves on rollers, which are turned through suitable worm and spur reduction gear by an electric motor of about 6-B.H.P. The tippler can discharge about eight to ten trucks per hour, and the complete revolution occupies about two minutes, the remainder of the time being taken up in entering the full truck to the tippler, clamping down and removing the empty truck.

As the coal leaves the trucks it falls into a receiving hopper built of concrete, below the rail level, lowering about 20 tons of coal, from which it flows by gravity through a shoot into a "Bennis" U-link steel chain conveyor.

We may add that in this particular case the coal is supplied to the stokers by a number of "Bennis" independent elevators, one elevator being provided

Rapid Railway Truck Discharge.

for each boiler, so that each boiler, with its elevator, forms a separate unit, and can be put into or out of service without interfering with any of the other boilers.

Another type of truck discharge plant is that by which standard railway trucks are emptied by allowing the coal to flow by gravity through the end door of the truck. It consists of a massive ram, on one end of which a clutch is fixed, which engages with the rear axle of the truck.

The ram is raised and lowered by a screw thread. A similar thread is cut in the hole of a phosphor-bronze worm wheel, which is turned by a mild steel worm operated through spur reduction gear from an electric motor.

The worm wheel and worm are contained in an oil bath, which oscillates on trunnion bearings. The purpose of this oscillation is to allow the top of the ram to move sideways and follow the path of the truck axle as it rises. The front wheels of the truck which do not leave the track can be chocked in position.

When the tippler is not in use, the ram is berthed in a vertical position in a pit beneath the ground.

About 5-B.H.P. is required to raise a full 10-ton truck, and the tipper can be arranged to drive by a belt from adjacent shafting, if electric power is not available.

ECONOMIES IN THE GENERATION AND USE OF STEAM.

By Sidney F. Walker, R.N., M.I.E.E., M.I.M.E.

(*Continued from page 17.*)

Other Distinct and Important Advantages.

Apart from the longer ranges of temperature and pressure that working with a condenser provides, there are other distinct and very important advantages. With the suface condenser, which is gradually displacing the other forms, the condensate is available as feed water for the boiler; its temperature is usually above that of the water otherwise available for the purpose; also in modern condensers, the air that comes over with the steam from the boiler should be very largely abstracted, and what is of equal importance, the salts of lime and magnesium with which river and well waters are so frequently charged. As is well known, water that is exposed to the atmosphere absorbs a certain quantity of air; in some careful tests that were made in America it was found that city water at 52 deg. Fah. contained over 4 per cent of air, while feed water at 187 deg. Fah. contained less than 1 per cent. It has also been found by further recent tests in America, that the air to be dealt with by air pumps working on condensers connected to steam turbines is only from $\frac{1}{4}$ per cent to $\frac{1}{2}$ per cent of the weight of steam.

The Early Days of the Surface Condenser.

In the early days of the surface condenser, when all the air carried over by the steam was returned to the boiler in the feed water formed from the condensate, it was found that the presence of the air, and carbonic acid gas, which is also present in water, and is carried over with the steam, had a very deleterious effect upon the iron and steel work of the boiler. In modern condensing plant, the air is separated from the condensate to a very large extent, and is pumped out of the condenser by its own pump, only the small fraction mentioned above being left in the feed water. The advantage of having pure, or very nearly pure water to feed the boiler will be at once appreciated, when it is remembered that, according to Professor Thurston, one-sixteenth inch of scale on the heating surface of a boiler may cause a waste of nearly one-eighth of its efficiency; while he estimates that the waste increases as the square of the thickness of the deposit. An eminent practical steam engineer has estimated that one-tenth inch of scale offers as much thermal resistance as a plate of steel 10 in. thick. Of course, some water from outside has to be employed, but with care the make-up should be small, and a small water softening plant should be able to deal with it.

The Condensate and High Vacuum.

A point has arisen in connection with the use of the condensate as boiler feed, as to the advisability

of employing very high vacuum. The temperature of the condensate with a vacuum of 29 in. is approximately 70 deg. Fah., while with a vacuum of 25 in. it is in the neighbourhood of 120 deg. Fah., and with a vacuum of 28 in. it is 100 deg. Fah. For ocean steamers the difficulty has been met by utilising the exhaust of the auxiliaries, which is fairly considerable in a large ship, in a special manner; on shore, the difficulty would apparently be overcome by the adoption of another modern improvement, allowing the exhaust steam to flow through a feed water heater on its way to the condenser. A double object is obtained by this method, a smaller quantity of circulating water is required in the condenser itself, the feed water acting as cooling water, and the temperature of the feed water being raised sufficiently to allow of its being taken to the "Economiser." It will be remembered that it has been shown to be distinctly advantageous to heat the water to the boiler temperature, or as near that figure as can be obtained, even by the use of live steam; it must, therefore, be distinctly more advantageous to utilise the exhaust steam in this way.

The Difficulties in the Way of Obtaining High Vacuum.

With modern condensing plant, the difficulties are nothing like as great as with the older plant that was almost universally employed before the advent of the steam turbine. One of the difficulties, the additional cooling water required, has already been referred to; that has been reduced within reasonable limits by the improvements that have been made, principally, as the writer understands the matter, the separation of the uncondensable gases, air, carbonic acid, etc. The ability of water to dissolve gases varies inversely with its temperature, and directly with the pressure under which the gases are held when they are being absorbed by the water. A very good illustration of this is obtained from the mineral water and bottled beer industries. In both of these, carbonic acid gas has to be forced into a liquid; water with some flavouring materials in the case of mineral water, and beer in the other industry. Beer is, of course, merely water with certain substances dissolved in it; in both cases carbonic acid gas is pumped into the liquids to give them the sparkle that is so much required, and is so much in evidence in good bottled beers and good mineral waters. To enable the liquid, in both cases, to absorb the requisite quantity of carbonic acid, its temperature is lowered very considerably, and the gas is forced in under pressure. The greater the pressure, and the lower the temperature, the greater is the percentage of carbonic acid absorbed per lb., or per pint, of the liquid. The other side of the question in connection with these industries is of even greater importance, and more instructive. As the temperature of the liquid rises, its ability to hold the gas decreases; the gas comes away if the temperature is seriously increased, and often sets up a dangerous pressure inside the bottles holding the liquid. The writer remembers a very striking instance of this, when going round the world a good many years ago. A considerable quantity of bottled beer was taken on board for the gun-room mess at a temperate port in the southern hemisphere; while going through the tropics, a very large quantity of it was lost, owing to the bottles bursting. There is another lesson to be learnt from the behaviour of inferior mineral water, after a bottle is opened; it is common experience that the sparkle is all gone in about the first half-glass, while with good mineral water, it will continue, unless the bottle is put on one side, for several minutes at any rate. The writer has mentioned this, because it appears to him to throw such a striking light upon the working of a surface condenser; when the condensate is at a high temperature it expels air and carbonic acid; when it is at a low temperature it retains them, and is ready to absorb more, such as may enter, for instance, through an air leak in the casing of the condenser; also when the pressure to which the condensate is exposed is small, or decreases, it will give up its air and carbonic acid, while if the pressure is increased, it will retain them. It appears to the writer, therefore, that the lines upon which condensers should be run should be to encourage the hot condensate to give up its air and carbonic acid, and then to drain it away out of reach of any air that may be present.

In the modern condenser, of which the Contraflo is a good example, these points are studied; the condenser itself is divided into sections, and arrangements are made to carry off the air at a higher level than that through which the condensate flows, and to prevent any air that may enter from reaching the condensate.

(To be continued).

BOYS' WELFARE ASSOCIATION.

The Boys' Welfare Association, which has been established for the encouragement and assistance of employers in promoting the welfare of their young male employees, has already made substantial progress, many of the principal engineering firms having joined as members, while applications or enquiries for particulars of the movement are coming in every day. An influential Council has been formed consisting of Sir W. Beardmore, Bart. (W. Beardmore and Co. Ltd.), Chairman; Mr. W. H. Allen (W. H. Allen, Son, and Co. Ltd.), Sir R. Baden-Powell, K.C.B., K.C.V.O. (Boy Scouts' Association), Mr. F. S. Button, (A.S.E.), Sir G. F. Carter, K.B.E. (Cammell, Laird and Co. Ltd.), Sir K. T. Crossley, Bart. (Crossley Bros. Ltd.), Mr. J. Denny (W. Denny Bros. Ltd.), Mr. H. C. Dickson (Halesowen Steel Co. Ltd.), Mr. C. G. Gilbertson, (W. Gilbertson and Co. Ltd.), Major-General Sir E. P. C. Girouard, K.C.M.G., D.S.O. (Sir W. G. Armstrong, Whitworth and Co. Ltd.), Sir Alexander Gracie, K.B.E. (Fairfield Shipbuilding and Engineering Co. Ltd.), the Rt. Hon. J. Hodge, M.P., Minister of Pensions, Sir G. B. Hunter, K.B.E., D.Sc. (Swan, Hunter, and Wigham Richardson Ltd.), Mr. S. Mavor (Mavor and Coulson Ltd.), Mr. S. Osborne (S. Osborne and Co. Ltd.), Sir Herbert Rowell, K.B.E. (R. and W. Hawthorne, Leslie and Co. Ltd.), Mr. Douglas Vickers (Vickers Ltd.). The Hon. Treasurer is Mr. S. E. Alley (Sentinel Wagon Co. Ltd.), and the Rev. Robert R. Hyde is the Director.

The offices of the Association are at Sanctuary House, Tothill Street, S.W.1., where all enquiries should be addressed.

A CAUSE OF FAILURE IN BOILER PLATES.

By WALTER ROSENHAIN, D.Sc., F.R.S., and D. HANSON, M.Sc.

(From the National Physical Laboratory.)

(*Continued from page 6.*)

THE microstructure corresponding to the various forms of treatment referred to in Table II. are illustrated in Figs. 8, 9, and 10—(the magnification in all cases is 150 diameters). Fig. 8 refers to the last specimen mentioned in the table, having the lowest impact figure and correspondingly showing the largest development of grain growth in the carbonless bands. Fig. 9 refers to the material as normalised and annealed at 650 deg. Cen. without intermediate deformation. It will be seen that here there is no appreciable difference in grain size between the carbonless band and the adjacent steel. Finally, Fig. 10 refers to the material which has been severely deformed and subsequently annealed at 650 deg. Cen., giving a high impact figure. Here

FIG. 8.

it will be seen that the grain has been very much refined even in the carbonless areas, and this corresponds in a striking manner with the very high impact figure, 11.7.

When the evidence above described is carefully considered, it will be seen to afford a considerable degree of proof of the view that the brittleness, as evidenced by the very low impact figures and actual failure in manufacture which has been found in the plate under discussion, arises from the existence of coarse ferrite crystals due to grain growth in the carbonless bands of the steel, and that this grain-growth is the result of a moderate amount of deformation in the cold, followed by low temperature annealing. It is further evident that normalising the material, or indeed merely heating it to a temperature above the critical range, is sufficient entirely to obliterate this grain growth and all its evil effects.

It will be seen that this conclusion indicates that the presence of carbonless bands, which is regarded as a normal feature and has not hitherto been considered a serious source of danger or weakness in a boiler plate, may become the cause of failure if associated with a suitable combination of mechanical deformation and low temperature annealing. If carbonless bands are to be regarded as a normal feature in boiler plates—and in existing practice this is probably inevitable—and if deformation in

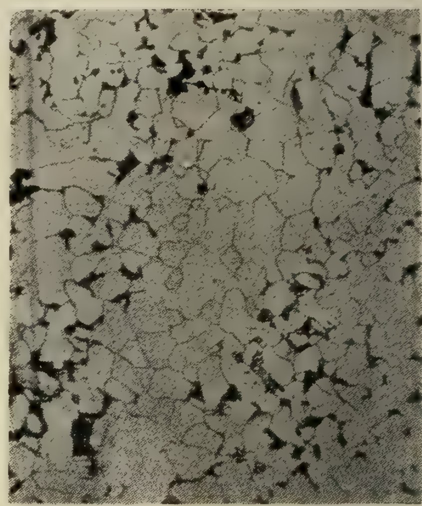


FIG. 9.

the cold, such as bending, etc., is otherwise a desirable practice, it seems that subsequent normalising is necessary, or certainly desirable, as a safeguard against dangers of the kind described here.

In order further to test the view which has been advanced above, the authors have endeavoured to

FIG. 10.

carry out similar experiments and tests on other samples of boiler plate, but the other samples at their disposal came in every case from plates of much smaller size and thickness, with the result that the banding, where it existed to a marked extent, was on a much smaller scale. Experiments on these plates were, however, made, in order that the results

Weights of Lengths of Rolled Steel Sections.

Beam 15 in. × 6 in. × 59 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	5 1 2	10 2 4	0 15 3 6	1 1 0 8	1 6 1 10	1 11 2 12	1 16 3 14	2 2 0 16	2 7 1 18	0
1	0 2 3	5 3 5	11 0 7	0 16 1 9	1 1 2 11	1 6 3 13	1 12 0 15	1 17 1 17	2 2 2 19	2 7 3 21	1
2	1 0 6	6 1 8	11 2 10	0 16 3 12	1 2 0 14	1 7 1 16	1 12 2 18	1 17 3 20	2 3 0 22	2 8 1 24	2
3	1 2 9	6 3 11	12 0 13	0 17 1 15	1 2 2 17	1 7 3 19	1 13 0 21	1 18 1 23	2 3 2 25	2 8 3 27	3
4	2 0 12	7 1 14	12 2 16	0 17 3 18	1 3 0 20	1 8 1 22	1 13 2 24	1 18 3 26	2 4 1 0	2 9 2 2	4
5	2 2 15	7 3 17	13 0 19	0 18 1 21	1 3 2 23	1 8 3 25	1 14 0 27	1 19 2 1	2 4 3 3	2 10 0 5	5
6	3 0 18	8 1 20	13 2 22	0 18 3 24	1 4 0 26	1 9 2 0	1 14 3 2	2 0 0 4	2 5 1 6	2 10 2 8	6
7	3 2 21	8 3 23	14 0 25	0 19 1 27	1 4 3 1	1 10 0 3	1 15 1 5	2 0 2 7	2 5 3 9	2 11 0 11	7
8	4 0 24	9 1 26	14 3 0	1 0 0 2	1 5 1 4	1 10 2 6	1 15 3 8	2 1 0 10	2 6 1 12	2 11 2 14	8
9	4 2 27	10 0 1	15 1 3	1 0 2 5	1 5 3 7	1 11 0 9	1 16 1 11	2 1 2 13	2 6 3 15	2 12 0 17	9

Weight of Beam advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight	lbs.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight
	4·92	9·84	14·76	19·68	24·60	1 1·52	1 6·44	1 11·36	1 16·28	1 21·20	1 26·12	2 3	

Weights of Lengths of Rolled Steel Sections.

Beam 15 in. × 6 in. × 59 lbs. per foot.

[ALL RIGHTS RESERVED.]

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 12 2 20	5 5 1 12	7 18 0 4	10 10 2 24	13 3 1 16	15 16 0 8	18 8 3 0	21 1 1 20	23 14 0 12	0
10	0 5 1 2	2 17 3 22	5 10 2 14	8 3 1 6	10 15 3 26	13 8 2 18	16 1 1 10	18 14 0 2	21 6 2 22	23 19 1 14	10
20	0 10 2 4	3 3 0 24	5 15 3 16	8 8 2 8	11 1 1 0	13 13 3 20	16 6 2 12	18 19 1 4	21 11 3 24	24 4 2 16	20
30	0 15 3 6	3 8 1 26	6 1 0 18	8 13 3 10	11 6 2 2	13 19 0 22	16 11 3 14	19 4 2 6	21 17 0 26	24 9 3 18	30
40	1 1 0 8	3 13 3 0	6 6 1 20	8 19 0 12	11 11 3 4	14 4 1 24	16 17 0 16	19 9 3 8	22 2 2 0	24 15 0 20	40
50	1 6 1 10	3 19 0 2	6 11 2 22	9 4 1 14	11 17 0 6	14 9 2 26	17 2 1 18	19 15 0 10	22 7 3 2	25 0 1 22	50
60	1 11 2 12	4 4 1 4	6 16 3 24	9 9 2 16	12 2 1 8	14 15 0 0	17 7 2 20	20 0 1 12	22 13 0 4	25 5 2 24	60
70	1 16 3 14	4 9 2 6	7 2 0 26	9 14 3 18	12 7 2 10	15 0 1 2	17 12 3 22	20 5 2 14	22 18 1 6	25 10 3 26	70
80	2 2 0 16	4 14 3 8	7 7 2 0	10 0 0 20	12 12 3 12	15 5 2 4	17 18 0 24	20 10 3 16	23 3 2 8	25 16 1 0	80
90	2 7 1 18	5 0 0 10	7 12 3 2	10 5 1 22	12 18 0 14	15 10 3 6	18 3 1 26	20 16 0 18	23 8 3 10	26 1 2 2	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight
	26 6 3 4	52 13 2 8	79 0 1 12	105 7 0 16	131 13 3 20	158 0 2 24	184 7 2 0	210 14 1 4	237 1 0 8	263 7 3 12	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.
Beams 15 in. × 5 in. & 10 in. × 6 in. × 42 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 3 0	7 2 0	11 1 0	0 15 0 0	0 18 3 0	1 2 2 0	1 6 1 0	1 10 0 0	1 13 3 0	0
1	0 1 14	4 0 14	7 3 14	11 2 14	0 15 1 14	0 19 0 14	1 2 3 14	1 6 2 14	1 10 1 14	1 14 0 14	1
2	0 3 0	4 2 0	8 1 0	12 0 0	0 15 3 0	0 19 2 0	1 3 1 0	1 7 0 0	1 10 3 0	1 14 2 0	2
3	1 0 14	4 3 14	8 2 14	12 1 14	0 16 0 14	0 19 3 14	1 3 2 14	1 7 1 14	1 11 0 14	1 14 3 14	3
4	1 2 0	5 1 0	9 0 0	12 3 0	0 16 2 0	1 0 1 0	1 4 0 0	1 7 3 0	1 11 2 0	1 15 1 0	4
5	1 3 14	5 2 14	9 1 14	13 0 14	0 16 3 14	1 0 2 14	1 4 1 14	1 8 0 14	1 11 3 14	1 15 2 14	5
6	2 1 0	6 0 0	9 3 0	13 2 0	0 17 1 0	1 1 0 0	1 4 3 0	1 8 2 0	1 12 1 0	1 16 0 0	6
7	2 2 14	6 1 14	10 0 14	13 3 14	0 17 2 14	1 1 1 14	1 5 0 14	1 8 3 14	1 12 2 14	1 16 1 14	7
8	3 0 0	6 3 0	10 2 0	14 1 0	0 18 0 0	1 1 3 0	1 5 2 0	1 9 1 0	1 13 0 0	1 16 3 0	8
9	3 1 14	7 0 14	10 3 14	14 2 14	0 18 1 14	1 2 0 14	1 5 3 14	1 9 2 14	1 13 1 14	1 17 0 14	9

Weight of Beam advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight	lbs. 3·5	lbs. 7·0	lbs. 10·5	lbs. 14·0	lbs. 17·5	lbs. 21·0	lbs. 24·5	q. lbs. 1 0·0	q. lbs. 1 3·5	q. lbs. 1 7·0	q. lbs. 1 10·5	q. lbs. 1 14·0	Weight

Weights of Lengths of Rolled Steel Sections.
Beams 15 in. × 5 in. & 10 in. × 6 in. × 42 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	1 17 2 0	3 15 0 0	5 12 2 0	7 10 0 0	9 7 2 0	11 5 0 0	13 2 2 0	15 0 0 0	16 17 2 0	0
10	0 3 3 0	2 1 1 0	3 18 3 0	5 16 1 0	7 13 3 0	9 11 1 0	11 8 3 0	13 6 1 0	15 3 3 0	17 1 1 0	10
20	0 7 2 0	2 5 0 0	4 2 2 0	6 0 0 0	7 17 2 0	9 15 0 0	11 12 2 0	13 10 0 0	15 7 2 0	17 5 0 0	20
30	0 11 1 0	2 8 3 0	4 6 1 0	6 3 3 0	8 1 1 0	9 18 3 0	11 16 1 0	13 13 3 0	15 11 1 0	17 8 3 0	30
40	0 15 0 0	2 12 2 0	4 10 0 0	6 7 2 0	8 5 0 0	10 2 2 0	12 0 0 0	13 17 2 0	15 15 0 0	17 12 2 0	40
50	0 18 3 0	2 16 1 0	4 13 3 0	6 11 1 0	8 8 3 0	10 6 1 0	12 3 3 0	14 1 1 0	15 18 3 0	17 16 1 0	50
60	1 2 2 0	3 0 0 0	4 17 2 0	6 15 0 0	8 12 2 0	10 10 0 0	12 7 2 0	14 5 0 0	16 2 2 0	18 0 0 0	60
70	1 6 1 0	3 3 3 0	5 1 1 0	6 18 3 0	8 16 1 0	10 13 3 0	12 11 1 0	14 8 3 0	16 6 1 0	18 3 3 0	70
80	1 10 0 0	3 7 2 0	5 5 0 0	7 2 2 0	9 0 0 0	10 17 2 0	12 15 0 0	14 12 2 0	16 10 0 0	18 7 2 0	80
90	1 13 3 0	3 11 1 0	5 8 3 0	7 6 1 0	9 3 3 0	11 1 1 0	12 18 3 0	14 16 1 0	16 13 3 0	18 11 1 0	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lb. 18 15 0 0	t. c. q. lb. 37 10 0 0	t. c. q. lb. 56 5 0 0	t. c. q. lb. 75 0 0 0	t. c. q. lb. 93 15 0 0	t. c. q. lb. 112 10 0 0	t. c. q. lb. 131 5 0 0	t. c. q. lb. 150 0 0 0	t. c. q. lb. 168 15 0 0	t. c. q. lb. 187 10 0 0	Weight

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

ENGINEERING APPOINTMENTS OPEN.

TRADE ITEMS, NOTES, &c.

DECLINE IN THE RUSSIAN COAL OUTPUT.—According to "Golos Juga," the output of coal in the Vlassovo-Grujev district amounted in June last to only one-seventh of the normal yield; in other words, the usual summer output of coal declined from eight million to 1,300,000 pood (1 pood is 36 lbs.). It is curious to note that the small pits produced most this time, instead of the big mines, as usual. Of the Donetz-Gruschev mines, only one shaft is being worked, whilst at Petrovskaja and Makarovskaja working has been stopped altogether. Work has also come to an entire standstill at the coal pits of the Azov and Ruduschin coal companies. The outlook for the winter is very serious.

ELECTRIC SHUNTING LOCOMOTIVE.—The *Railway Gazette* is indebted to Mr. G. Hughes, chief mechanical engineer of the Lancashire and Yorkshire Railway, for particulars of the above, which has been designed and constructed at the company's works at Horwich. The locomotive is of the accumulator type with batteries divided into two parts, so that the two portions can be used in parallel, to give a voltage of 120, or when working in series 240 volts. The control system provides series parallel control on motors at 120 volts or 240 volts. There are ten notches on the controller for both voltages. The 120-volt supply is used for shunting purposes, giving a speed of about 4.5 miles per hour. The 240-volt supply is for running from place to place, the free running being 20 miles per hour on the level. The tractive force exerted at the rim of the wheel up to 2.3 miles per hour is 5,400 lb., and at the hourly rating 2,500 lb. at 4 miles per hour. The locomotive was designed to handle three loaded 20-ton coal waggons (90 tons) on an incline of 1 in 180. The engine can be operated by one man, and when the work is not continuous this man can perform other duties, it being left without any attention, but is ready at a moment's notice to perform shunting work. The capacity of the battery will admit of 3.2 hours continual shunting, or a 4 hours' continuous run "light" on the level at an average speed of 20 miles per hour. During the dinner-hour a boosting charge will give back to the battery 40 per cent of its total charge, raising the shunting capacity to 4½ hours. The locomotive is fitted with a vacuum brake and hand brake. The vacuum is produced by means of a small electrically-driven exhauster worked from either half of the battery.

QUEENSLAND LIGHTHOUSES.—Before a meeting of the Liverpool Engineering Society, Mr. Ramsbotham, Director of Lighthouses for the Commonwealth, gave an interesting lecture recently on the above subject. He explained that the towers of the lights consist of four-legged steel structures, sub-divided into four bars and braced in the usual way. The height of their platforms is 42 ft. 9 in. above the concrete foundations, the focal plane of the light being nearly 6 ft. higher. The foundations differ for each light. Those at Coquet Island and Clerke Island offered no special features, both being above high water and not subjected to any wave action. At Dhu Reef, where the actual site of the light is 18 in. below h.w.m.s.t., it it was determined that at a depth of 9 ft. 6 in. the coral conglomerate, intermixed with sand, was sufficiently dense to stand a load of 2·375 tons per square foot. For the Piper Island light, which is established on a coral reef, it was ultimately decided to drive a nest of five ferro-concrete piles under each pier, excavating and putting a reinforced slab, 19 ft. square and 3 ft. thick, on the top. The necessity of driving the piles to a "sett" was recognised, but none of them could be so driven. In the author's opinion, nothing can be allowed for skin friction for piles driven in coral, and he decided to increase the bearing area to 963 sq. ft., reducing the intensity of stress to 0·725 tons per square foot. Acetylene dissolved in acetone at ten atmospheres pressure is used, and there are ten cylinders, each containing 117 cubic ft., all coupled together. They are changed once a year. The light is turned on and off by a sun-valve, which is so delicate that the light has been seen to come into operation during a rainstorm. A pilot flame is always burning. The lights are of 1,500 candle-power, with a visibility of 13 miles. So far—*i.e.*, since 1913—no trouble has been experienced with any of these unattended lights. The first cost compares favourably with that of a manned light, and the running cost is only £30 against £57°.

might be regarded as a check on the observations already described. In the case of a plate half an inch thick, which may be referred to as No. 2, the chemical analysis was as follows:—

	Per Cent.
Carbon	0·123
Silicon	0·014
Sulphur	0·03
Phosphorus	0·057
Manganese	0 49

which again indicates a steel of very satisfactory composition. The general microstructure of this plate in the condition as received is shown in Fig.

Fig. 11.

II. It will be seen that a certain amount of banding is present, but not on the scale found in the first plate described above.

A piece of this plate was normalised at 950 deg. Cen., and portions were subsequently treated as follows:—

1. Hammered cold and annealed at 650 deg. Cen.
2. Hammered between 600 deg. Cen. and 700 deg. Cen., and annealed at 650 deg. Cen.
3 Annealed at 650 deg. Cen. without previous mechanical treatment.

(To be continued.)

INSTITUTE OF AUTOMOBILE ENGINEERS.

The first meeting of the Session of the Institution of Automobile Engineers was held at the Royal Society of Arts, John Street, Adelphi, W.C., on Wednesday, 2nd October, 1918, when the incoming President, Mr. A. A. Remington, of the Wolseley Motors Ltd., read his Presidential Address entitled "Some Probable Effects of the War on the Automobile Industry."

One quotation may be made from the address as being probably one which will appeal most generally to the industry—"At times we hear the suggestion that no one will be able to afford motor cars after the war, and this argument is so persistently advanced that I am sometimes tempted to wonder what degree of truth there is in such a statement. . . . After the war we shall doubtless suffer from severe taxation, and also under all the evils caused by the high cost of living, but, as the automobile is a time-saver, it seems to me that the adverse conditions of life will accentuate rather than diminish the necessity for it, as by being a time-saver it will be more than ever a necessity and money-maker. Therefore, although high costs of living will mean high costs both for material and labour, notwithstanding all this, the motor car business must and will flourish."

A very useful development of the work of the Institution was initiated in the election of a very considerable number of engineers who have identified themselves with the motor-cycle branch of the industry, and who have hitherto not to any considerable extent interested themselves in the work which the Institution has been doing. The elections already made will undoubtedly lead to many more members of this branch joining, and steps are being taken to hold at least four meetings in Birmingham in addition to the London meetings, when the many points connected with the design of motor cycles and their components which need discussion will be brought forward.

Particulars of the meetings to be held will be announced at an early date, and it is hoped that now that the Institution is paying special attention to this particular branch of the industry, motor cycle engineers will communicate with the Secretary with a view to election.

Attention is particularly drawn to the fact that the qualifications required for membership have been in no way relaxed with a view to admitting motor cycle engineers; applicants must make it quite clear to the Council that they are just as good "Engineers" as those who have hitherto been admitted.

The programme of papers for the session includes another valuable contribution by Mr. L. H. Pomeroy, of Vauxhall Motors Ltd., this time on "The Influence of Valve Lift and Combustion Chamber Design on Consumption," while the subject of "Agricultural Tractors" will again be dealt with by Mr. L. A. Legros. It is hoped also to have a paper on the Deisel Engine, which has hitherto not been dealt with by the Institution, and a paper by Mr. Opperman on "Electrical Vehicles" will, in view of the great development which has recently taken place in this type of vehicle, prove of great importance. The Institution has lately taken an active part in the negotiations with the Government for removing the disabilities which have been imposed upon inventors owing to the war, Mr. M. A. Adam, a member of Council, being Chairman of the Committee which has been dealing with the matter. In view of this work, a paper will be read on the question of "Patents" by Mr. G. D. Leechman, which will be of great assistance to inventors in avoiding snags and facilitating their work.

The Crompton Medal which is awarded annually by the Institution for the best Paper read during the Session has been awarded to Major H. P. Philpot for his Paper on "Some Experiments on Notched Bars."

London Graduates' Centre.

The London Graduates' Centre of the Institution of Automobile Engineers opened their Session on Thursday, 3rd October, 1918, when Mr. Pomeroy, who is the Chairman of the London Branch, gave an address on the "First Principles of Automobile Construction."

The great value of such an address to the junior members of the profession will be well understood, and it is hoped that more graduates this year will make use of these meetings to assist them in their profession.

Mr. W. R. W. Rendall, of 73, Downs Park Road, Hackney Downs, E. 8, is Hon. Secretary of the Graduates' Section this year, and those desirous of joining should communicate with him.

MODERN STEAM TURBINES.

By J. HUMPHREY.

(*Continued from page 9.*)

The Oil Pump.

The oil pump does not differ in any marked degree from the usual type of pump commonly used for lubricating steam turbines. It is driven by means of worm gearing from the vertical governor shaft and is mounted in an oil tank together with an oil cooler and a hand pump, which is used when starting the turbine. The method of preventing oil leakage from the bearing boxes is shown in Fig. 66, the body of the box surrounding the bearings being provided with two grooves *c* and *d*, and with narrow ribs *e*, the edges of which closing tightly on the turbine shaft or generator shaft and in the shaft outside the journal is turned a groove *f*, the edges of which throw off the oil to the groove *d*, a drain pipe *g* is connected, and through this pipe the waste oil is discharged. The groove *c* communicates with the discharge pipe 20 in Fig. 67, and with the narrow oil passage 23 at the bearing joint, and this passage prevents leakage of the oil through the joint between the lower and upper halves of the bearing box. Of course, the turbine is provided with the usual controlling and emergency governors, the centifrugal controlling governor being, as already stated, mounted on the same vertical shaft as that which drives the oil pump. This governor does not act upon the control valve directly, but through the medium of oil under pressure, the motion of the valve corresponding to that of the governor sleeve The emergency governor which shuts off the steam in the event of the speed becoming excessive, acts by releasing a trigger on a slide valve, which cuts off the oil pressure from the oil cylinder of the oil operated controlling valve, and at the same time both ends of the oil pressure cylinder are put into communication with each other, so that the oil pressure below the piston to which the controlling valve is connected is destroyed, and the governor valve is immediately closed by a spiral spring above the piston. A view of one of the 1,000 kilowatt Brush Ljungstrom turbines installed in the Luton electric lighting station is shown in Fig. 68. (*To be continued.*)

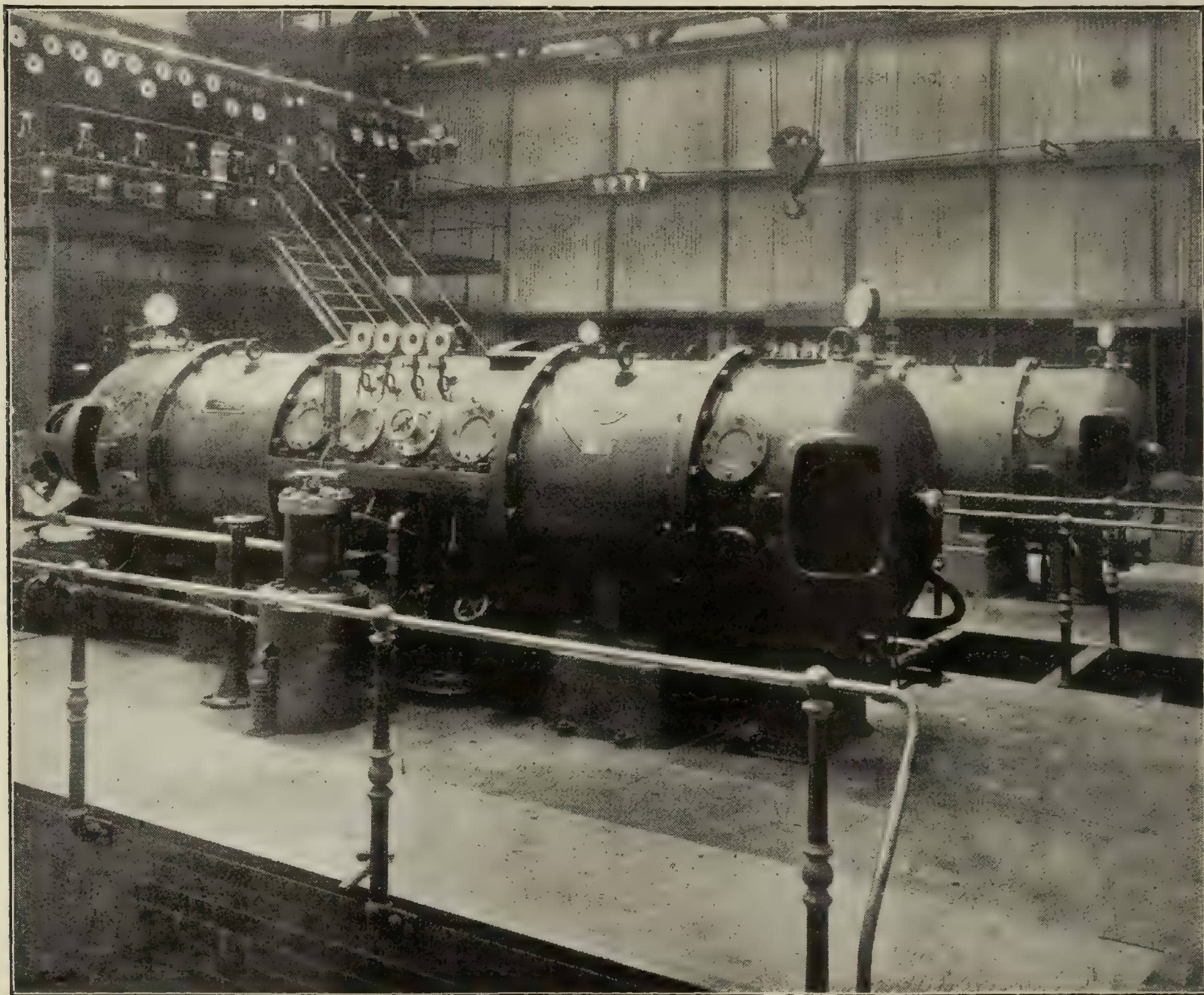


FIG. 68.—1,000 KILOWATT BRUSH-LJUNGSTROM TURBINES AT LUTON.

HYDRAULIC RAMS FOR CITY WATER SUPPLY.

By T. H. Carver.

The Maple Leaf pumping station of the City of Seattle represents a new departure in the common practice for the construction of water-power pumping stations. This plant should be of interest to engineers, since it is believed that it develops perhaps the highest known combined power and pumping efficiency of any existing plant of like size or larger, and in addition shows unusual economy in installation and operating costs. It conststs of two 12 in. Hill hydraulic rams operating under a 50 ft. power head and against a pumping lift of 140 feet from a point above the rams to the full tank level. Performance tests showed a range of capacity of water pumped from 720,000 to 1,300,000 gallons per day with corresponding efficiencies of from 90.8 per cent to about 85 per cent. The normal daily operating capacity is something over 1,000,000 gallons of water pumped.

Eventually the plant capacity will take care of some 28,000 population and provide ample fire protection for the 790 acres involved. The rams are simple in operation. They are started with an auxiliary starting valve, and adjustment for capacity is made by turning an adjusting screw up or down. All mechanical movement is limited to simple valve shifts of small motion, and as all moving parts are inside the machines, in water, no oil is used or required. The rams operate continuously in the locked gatehouse and inspection is made only once or twice a week by the regular water department employee. Maintenance and renewals, limited largely to new valve seats, are estimated to cost not to exceed 10 dollars per year per ram. As wear is exceedingly light, the rams maintain their full efficiency for long periods.

RAILWAY ELECTRIFICATION AS A MEANS OF SAVING FUEL.

Where electricity has been substituted for steam in the operation of railroads, fully 50 per cent increase in available capacity of existing tracks and other facilities has been demonstrated. This increased capacity has been due to a variety of causes, but largely to the increased reliability and capacity of electric locomotives under all conditions of service, thus permitting a speeding-up of train schedules by some 25 per cent under average conditions.

It is estimated that something like 150,000,000 tons of coal were consumed by the railroads in the year 1917. It is now known, from the results from such electrical operation of railroads as we already have in this country, that it would be possible to save at least two-thirds of this coal if electric locomotives were substituted for the present steam locomotives. On this basis there would be a saving of over 100,000,000 tons of coal in one year. This is an amount three times as large as the total coal exported from the United States during 1917. The carrying capacity of our steam roads is also seriously restricted by the movement of coal required for the haulage of the trains themselves. Estimates indicate that fully 10 per cent of the total ton-mileage movement behind the engine drawbar is made up of company coal and coal cars, including in this connection the steam-engine tender and its contents. The consumption of fuel oil by railroads is also very great, 40,000,000 barrels, it is said, having been used in 1913, or nearly 15 per cent of the total oil produced.

The possible use of water power should also be considered. According to estimates, there are not less than 25,000,000 horse power of water power available in the United States, and if this were developed and could be used in operating our railroads, each horse power so used would save at least six pounds of coal now burned under the boilers of our steam locomotives. It is true that this water power is not uniformly distributed in the districts where the railroad requirements are greatest, but the possibilities indicated by the figures are so impressive that they justify careful examination as to the extent to which water power could be so employed and the amount of coal that could be saved by its use.

HEAT APPLIED TO ENGINEERING.

By Prof. W. W. Haldane Gee, B.Sc., M.Sc.Tech.

(*Continued from Vol. VI., page 475.*)

The Clinical Thermometer.

Although the clinical thermometer cannot be directly regarded as an engineer's instrument, its construction and use deserves study, for it not only gives an indication of the working condition of the most remarkable of all engines, the human body, but it may be employed as a registering maximum thermometer for certain experimental work.

The working range of a clinical thermometer is between 80 deg. to 110 deg. Fah., and has relatively long degrees enabling tenths to be estimated. The bulb is small so that the temperature of the patient can be quickly ascertained. The limited volume of mercury in the bulb necessitates a very fine capillary, which is often elliptical, giving a wider thread. By having a lens shaped front to the stem, so as to magnify the size of the thread, greater facility in reading is produced. Various devices have been adapted to maintain the reading at the highest temperature reached when the instrument is in use. The most usual is to provide a contraction at the base of the capillary which allows the mercury to expand, but prevents its return until the mercury is forced back by a jerk or swinging motion. The divisions are usually etched directly on the stem, but a better method is to have a separate scale enclosed in an outer glass tube, for, it is thought, that the graduations in the former case may retain septic matter, hence the enclosed type are known as "asceptic" thermometers. The smooth glass can be perfectly sterilised and the scale is protected from the sterilising fluid. Clinical thermometers are known as ½, 1, and 2 minute thermometers, according to the time required to attain the maximum reading . When the lag is small a very small and rather fragile bulb is essential.

It is interesting to note that the temperature recorded by a thermometer placed in the mouth of a healthy person is between 98.5 deg. to 99.5 deg. Fah. Active exercise may somewhat increase the temperature, whilst during rest and sleep there is a lowering of temperature. In summer the temperature is but little higher than in winter—the human body possessing a most remarkable power of keeping its temperature nearly constant under the most diverse conditions of climate. In disease, as in pneumonia, it may rise to 107 deg., and in Asiatic cholera it may fall as low as 77 deg. Various drugs,

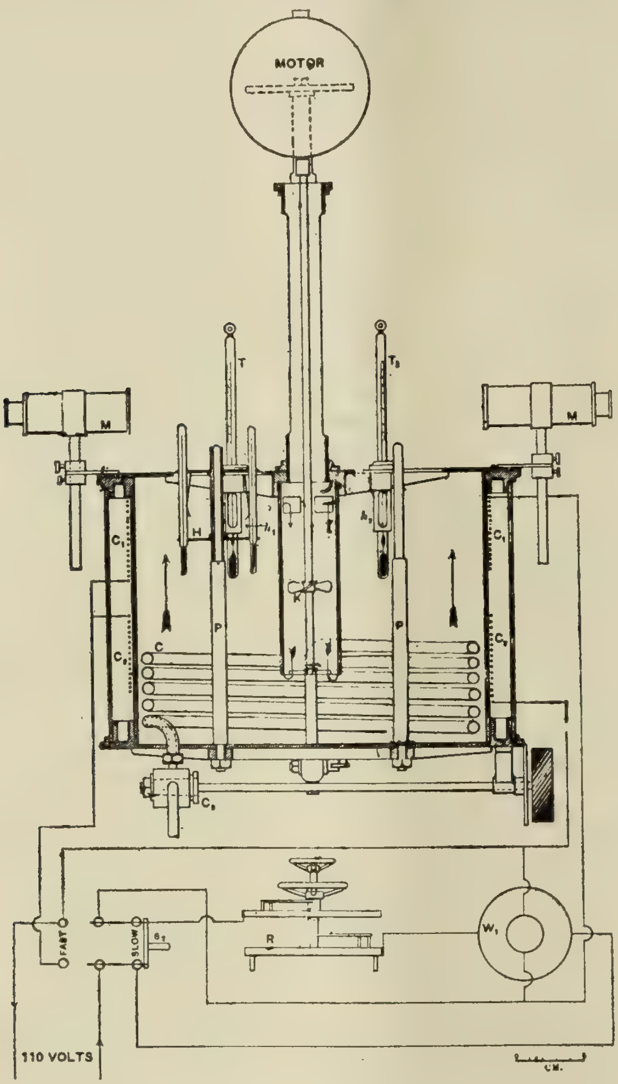


Fig. 15.

such as antipyrine, lower the temperature, and the same is always the case with alcohol. The supply of clinical thermometers has been taken over by the Ministry of Munitions, and makers are informed that their instruments must pass the tests of the National Physical Laboratory before acceptance. If a thermometer fails to pass, it is broken so that it cannot be placed on the market. About 10,000 clinical thermometers are tested each month, the work being done mainly by a special staff of women.

The American Bureau of Standards has also systematised the testing of clinical thermometers. Fig. 15 shows the details of the comparison bath used. It consists of a double-walled brass vessel, the water in the inner part being thoroughly stirred by a small propeller K, which is driven at a high speed by a little motor M. The propeller forces the water down through the middle tube and then upwards as indicated by the arrows. The outside of the tank is covered with sheet mica on which two heating coils C_1 and C_2 are wound. They are of cotton-covered constantine wire, which is held in place by the help of shellac. Each coil has a resistance of 80 ohms, and they are connected, through a rheostat, with a 110-volt supply. The coils may be used in parallel (for fast heating) or in series (for slow heating) by the switch S_2. The power used for slow heating is measured by a wattmeter W_1. Within the tank is a coil of copper tubing through which hot or cold water can be circulated, the amount of which can be controlled by a cock C_3.

The cage for 96 thermometers is supported by four rods, of which P and P show two. The two standard thermometers T_1 and T_2 are held from the roof of the tank, and their readings are taken by the two reading microscopes M and M. The first test point is 96 deg., to which the temperature is brought by the use of the heating coils. Since the clinical thermometers are registering, it is not necessary to read them in the bath. The cage full is removed from the bath, and mounted on a stand, when the readings can be quickly taken by a special reading microscope, the cage being revolved so that each in turn is brought into the field of view. The thermometers are now returned to the bath, and brought to 100 deg.; they are now removed and read. This procedure is repeated at 104 deg. and 108 deg. When these tests are completed, the mercury in the thermometer can be lowered below 95 deg. by the use of a whirling table, and the series of tests can then be repeated.

(To be continued.)

AN EXHIBITION OF "KEY" INDUSTRIES.

Mr. H. J. Mackinder, M.P., Chairman of the Tariff Reform League, desires to draw attention to the fact that, by permission of the Ministry of Munitions, an Exhibition of new British and "Key" Industries, organised by the Industrial Section of the League, will be held at the Central Hall, Westminster, London, this month. The Exhibition will be opened, by ticket only, on Monday, Oct. 7th, and to the general public, admission free, on and after Tuesday, October 8th. It will remain open until Oct. 22nd, after which it will be shown in Manchester and other leading provincial centres of population. The object of the Exhibition is to illustrate the facts respecting the more important of the so-called "Key" or "Pivotal" industries recommended for special treatment by the Government Committee on Industrial and Commercial Policy after the War. The Exhibition has been very carefully thought out, and the Committee have secured the active co-operation and assistance of the more important firms interested in the industries concerned, many of whom have generously contributed valuable exhibits and expert

information. The Exhibition will also include a very remarkable and indeed unique collection of photographs and diagrams. All interested are invited to communicate with Mr. Edward J. Duveen, chairman of the Industrial Section, Tariff Reform League, 7, Victoria Street, London, S.W.1.

CHIMNEY STACKS.

By James Claughton.

(Continued from Vol. VI., page 436.)

Quantity of Gases Delivered by Chimney Stacks.

The mathematical formulæ for determining the quantity and the velocity of the flow of various gases through channels, pipes, etc., are very vaguely represented in the scientific literature now available. Generally speaking, considering the importance of the subject and its extensive use in practically every branch of engineering, it is a subject which can provide plenty of scope in the way of physical research work.

Having briefly drawn attention to the importance of this subject, I will endeavour to give in a practical sense and form the result of some of my observations, and attempt to supply a series of suitable working formulæ for calculating purposes.

A Simple Illustration.

The smoke from an ordinary open coal fire appears to the eye to ascend very slowly into the atmosphere in a series of spirals, or a kind of rolling action. If a smooth tube be placed over the fire so as to form a chimney, and in this tube we were to place a piece of glass to form a semi-cylindrical window, it will be observed that instead of a spiral or rolling action we now get a phenomenon which very closely resembles that of a liquid flowing through a pipe under pressure; that is, instead of the gases moving very slowly, they now move very quickly. This change is brought about by the presence of a draught. If we lengthen or shorten the tube, there is a greater or lesser velocity, respectively, of the ascending gases. Further, if we increase or decrease the diameter of the tube, we obtain a similar result. These facts are very important and should be carefully noted.

Contrary to the general trend of theory, it is found in practice that the best results in the past have been obtained by a comparatively slow velocity of the ascending waste gases up the chimney. Apparently the chief reason for adopting a slow velocity was to enable the hot gases to play as long as possible upon the flues and tubes of the boiler or economiser, which, in turn, transmit the heat so obtained to the water contained therein.

A chimney velocity of about 30 ft. per second for the waste gases is found to give very good results in present-day practice, this figure being about one-third the actual calculated theoretical initial velocity for any given amount of available draught.

Another Experiment.

Let us rivet several ⅛-in. thick flat bar steel hoops at intervals on the inside of an experimental tube, and take further observations with slow-moving gases. We find that the eddy currents now set up are so great as to diminish the quantity of the gases delivered by at least one half, or 50 per cent of the value as obtained with the tube having perfectly smooth sides. On examining a plant in working condition, we find that the above action does actually take place. For instance, in smoke coming out of the top of any large factory chimney, the rolling or eddy current action is quite evident.

Hydraulic engineers acting in co-operation with scientists have determined a series of rational formulæ that are applicable to liquids. The formulæ governing gases are very similar in many respects to those now generally used for gases. On the face of the proposition now before us, it appears to be quite feasible to determine a series of suitable formulæ for readily ascertaining the velocity of a flowing gas under a known pressure.

A point to remember when considering this proposition on the lines just stated is, if two liquids are mixed together which do not act chemically on each other are allowed to stand for a time, they will be found to have separated, the heavier liquid being at the bottom and the lighter liquid at the top. If two gases of different composition are mixed together, it will found that there has been a complete mixture; in fact, the greater the difference in heaviness of the two gases, the more rapid is the mixture. This latter fact applies equally in cases where the composition of the gases are such that no chemical combination can take place. This property in the mixture of gaseous matter is a very valuable and important one, especially so in the case of the gas carbon-dioxide, which is a poisonous gas, a product of combustion, and one-and-a-half times heavier than air. This gas, when mixed with air, is easily dispersed into the atmosphere, instead of remaining near to the earth in dense clouds.

Liquids are practically incompressible, whereas gases are easily compressed.

It is chiefly owing to the foregoing facts that the laws governing flow of gases through orifices and channels are not so simple as those relating to the flow of liquids. In any case local conditions will be a governing factor to a large extent, hence as we are dealing with chimney shafts our considerations will be those wholly in accordance with our immediate requirements for the work in question.

In chimney calculations, the difference of pressure absolute between the hot gases and the air outside is very slight, so that our formula can be made very simple. Since a gas is easily compressible, and because the volume of a given weight is dependable on the pressure, it naturally follows from the law

$$\frac{P_1 V_1}{RT_1} = \frac{P_2 V_2}{RT_2}$$

that the same weight of gas must pass any cross section of the pipe or conduit in the same interval of time.

In chimney work, the drop or loss of pressure can, if desired, be taken in terms equivalent to the draught. Therefore, loss of velocity may also be considered as a function of the draught, or loss of pressure; technically, the latter is often termed the "pressure drop."

(To be continued.)

A METHOD FOR THE DETERMINATION OF THE RELATION BETWEEN VAPOUR PRESSURES AND THEIR CORRESPONDING TEMPERATURES AT PRESSURES OF LESS THAN FIVE MILLIMETRES.

By W. R. Ham, Ph.D., J. C. Churchill, M.S., H. M. Ryder, M.S.

(Concluded from Vol. VI., page 477.)

Curve sheet No. 2 presents a curve showing the relation between vapour pressure and corresponding temperatures for acetophenone, a liquid which was investigated. The full curve was obtained by plotting the receiver pressures as measured against the corresponding lower limiting temperatures as obtained from curve sheet No. 1. The broken line curve was plotted from Kahlbaum.*

The extreme lower end of Kahlbaum's curve does not coincide with the one here obtained, but they rapidly come together as the pressures increase. According to the reference given above, Kahlbaum measured his pressures by comparing the height of a mercury column connected with his system with the barometric height, which method cannot be depended on for accurate results at low pressures.

The equation suggested by Biot as a general one for this curve, and which has already been mentioned—that is,

$$\log P = A + Bb^T$$

has been applied to the results here obtained, in combination with Kahlbaum's results. Points on the curve corresponding to pressures of 4, 300, and 760 mm. were used for the determination of the constants. The particular form of the equation as obtained was

$$\log P = 19.696 - 72.540 \times 0.993944^T$$

Vapour Pressure—Temperature Relations for Acetophenone.

Table I.

Temperature degree C.	Observed P, mm.	Kahlbaum's P, mm.
30	0.391	
31.65	0.444	
34.25	0.492	
36.45	0.583	
37.2	0.679	
39.8	0.844	
42.4	1,030	
44.1	1.157	
46.55	1,278	
48.0	1.370	
49.8	1.546	
54.0	2.055	
57.15	2.520	
60.05	3.112	
63.50	3.800	
65.0		5.0
66.0	4.50	
69.2	5.20	
79.0		10.0
79.7	9.6	
81.2	10.2	
85.4	12.8	
87.4		15.0
87.7	15.4	
92.0	17.7	
93.3		20.0
95.4	21.4	
98.2		25.0
100.3	26.8	
102.3		30.0
106.0		35.0

* *Zeitschrift für Physikalische Chemie*, 26, 603, 1898.

Values of P were found for corresponding values of T from this equation for various temperatures, and the results are shown in Table II., together with the values of P as obtained from the curve. It will be seen that this equation is an approximation, and not by any means accurate, although the points most liable to show some difference beween the calculated and observed values were the ones chosen.

Table II.

Temperature degrees C.	Observed P, mm.	Calculated P (Biot), mm.	Calculated P (Rankine), mm.
30	0.39	0.44	0.45
50	1.60	1.65	1.705
106	35.0	31.0	32.6
145.1	150.0	146.0	146.3
177.5	400.0	401.0	400.6

"Observed" values of P over 26 mm. of mercury are those given by Kahlbaum.

The equation of Rankine,

$$\log P = A - \frac{B}{T} - \frac{C}{T^2}$$

was also applied to the present case, exactly as was Biot's. With the constants determined, the equation took the form

$$\log P = 16.152 - \frac{3390.96}{T} - \frac{534{,}192.38}{T^2}$$

Several values of P as found from this equation are found in column 4 of the accompanying Table II. It will be seen that the curve of one equation follows very closely that of the other, and it would be hardly proper to say that either has any advantages over the other, so far as accuracy is concerned, at least in the present case. They are probably equally cumbersome in their manipulation.

It would seem in general, then, from the foregoing, that the actual mathematical representation of the relation between vapour pressures and temperatures, either by means of equations based on theory or by purely empirical forms, has not as yet been satifactorily accomplished. This relationship appears to be dependent on some phenomenon of which we have, as yet, slight knowledge.

(Concluded.)

REINFORCED CONCRETE.

By Edward Ingham, A.M.I.Mech.E.

Reinforced concrete, although generally believed to be a recent introduction, was used by the Romans over 2,000 years ago. It is, however, only within the past 40 or 50 years that the material has been employed for general constructional work. In Britain, particularly, engineers and architects have, until quite recently, been slow to recognise its advantages, but many British firms are now specialising in the production of the material.

Reinforced concrete, sometimes known as "ferro-concrete," is a combination of concrete and steel, the steel (generally in the form of bars or rods) being arranged to resist mainly the tensile stresses, while the concrete resists the compressive stresses.

Concrete is strong in compression, but weak in tension, and for this reason the plain material is only suitable for those constructions in which there are no important tensile stresses to be sustained. Steel, however, is very strong in tension, so that by a suitable arrangement of steel rods embedded in the

correct positions in the concrete, a most economical combination, suitable for resisting both tensile and compressive stresses, is obtained.

The uses of reinforced concrete are almost unlimited. At the present time, it is being employed for all sorts of constructional work, such as buildings, bridges, chimneys, tanks, reservoirs, sewers, barges, ships, and so on. In addition to economy of material, a number of advantages may be justly claimed for reinforced concrete over other forms of construction, amongst which may be mentioned durability, fire, shock and vibration-resisting properties, and the facilities which the material offers for speedy erection. All these advantages are important ones, so far as general buildings are concerned. With regard to durability, it is well known that the usual materials, timber, iron and steel, all have a tendency to deteriorate with age. Timber is especially liable to suffer, and although iron and steel may be preserved by painting, they tend to become weakened by fatigue sooner or later.

Reinforced concrete, on the other hand, is not only able to resist disintegration, but it actually increases in strength as time goes on. An objection sometimes urged against it is that the steel may corrode in course of time, and since the reinforcement is composed of bars and rods of comparatively small section, the safety of the structure may be thus endangered. Experience has, however, proved beyond all question that this objection is not valid, and many examples might be given to show that iron or steel which has been embedded in concrete for centuries has not been affected in any way.

The property of being able to resist satisfactorily the effects of fire is obviously an important advantage. In the case of a timber building, or even one in which a timber framing is employed, we are all familiar with the serious consequences of a fire. As regards buildings in which the framework is of steel, the results of a conflagration may not be so disastrous as with a timber building, but the beams and columns are liable to suffer severely under the effects of the heat, and may in consequence fail under the load they have to carry. With reinforced concrete, the concrete protects the steel, whilst the steel tends to hold the concrete together. Many instances are on record of buildings which have suffered very little from the effects of the most serious fires, and actual tests have shown conclusively that the material, although not absolutely fireproof, has excellent powers of resisting the combined effects of fire and water.

There is immense scope for reinforced concrete in the construction of wharves, piers, jetties, and so on, in which the material has to resist the action of the water. Both timber and steel are far inferior to reinforced concrete for this purpose. Timber not only suffers from the water, but it is attacked by marine worms and insects, and often deteriorates very rapidly. Steel, of course, oxidises and corrodes, but reinforced concrete does not appear to be appreciably affected in any way.

Like everything else, reinforced concrete has certain disadvantages. Perhaps the principal of these is the manner in which it sometimes cracks as a result of atmospheric changes, etc., but, with care, this objection may be overcome.

The appearance presented by reinforced concrete buildings is thought to be a disadvantage by some, who consider the walls look cold and unattractive, but this is a matter of opinion.

Reinforced concrete transmits sounds readily, and this is sometimes said to constitute a third objection, so far as buildings are concerned, since the sounds are liable to penetrate into adjoining rooms and so prove a nuisance.

The disadvantages mentioned are clearly not important, and certainly are not of sufficient moment to prejudice one against the use of the material for general constructional work. There are, it is true, a few architects and engineers who regard reinforced concrete with suspicion, but the undoubted reliability and the great scope of the material are now being generally recognised, and there can be little question that in the immediate future, reinforced concrete will be employed to a far greater extent than hitherto.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.

Sheffield Branch.

THE first lecture arranged by the Technical Committee of this branch was given by Mr. L. D. Parker, A.M.I.M.E., on October 18th, 1918, at the Applied Science Department of Sheffield University. The paper, entitled "Modern Machinery for Manufacturing Portland Cement," was illustrated by 25 lantern slides made from sectional drawings and photographs. An interesting discussion followed the reading of the paper, and a hearty vote of thanks was given to Mr. Parker for the time and trouble that must have been expended in the preparation of his lecture. Mr. F. H. Roberts was in the chair.—HERBERT SOUTHERN, Hon. Technical Secretary.

Publications.

The construction of the Forth and Tay Bridges, and other successful engineering schemes should be ample testimony as to the reliability of anything that **Sir William Arrol and Co. Ltd.,** of Parkhead, Glasgow, might undertake. The crane department of the firm has published two extremely well-illustrated booklets with reference to their shipyard cranes and "Timperley" transporters (the latter being chiefly used for the rapid handling of coal). Excellent photographs are shown of these machines in operation in various shipyards and ports, but owing to war-time restrictions details of some of the most recent installations cannot be at present published. The descriptive matter in both these booklets is in the French language, and for that reason should be most useful in the promotion of post-war business.

The County Chemical Co. Ltd., of "Chemico" Works, Birmingham, have just issued an interesting little booklet descriptive of their specialities. Besides their well-known rubber solution, which, it is stated, can be made to suit all requirements, and be made non-inflammable, if necessary, several other specialities are offered. "Abradim," an abrasive powder made in five grades, is suitable for engineers and toolmakers in the process of gauge-making, valve setting, etc., and the finer qualities for laboratory use in the microscopic examination of metals. This abrasive can be obtained also if desired in the form of paste, and is claimed to be absolutely free from acids or any deleterious matter. "Chemico Jointer" for making air, water, or steam joints, is stated to be quite satisfactory when used alone on surfaced faces, and insoluble in either oils or petrol. For those interested in welding and brazing, "Laffitte" Welding, Brazing, and Hardening Compounds are worthy of notice. Amongst others are "Chemico" soldering paste and fluid (apparently a formidable rival to other articles of that description), gas-engine oils, and other lubricants, paints, enamels, varnishes, and hard soaps, and "Chemico" rust preventer. These are days of substitutes, and we feel confident that the benefit of the firm's experience would be at the disposal of anyone in difficulties.

The Vacuum Oil Co. Ltd., of Caxton House, Westminster, have published a brochure in connection with vertical gas engines. These machines are both of the multiple-cylinder single-acting and the multiple-cylinder single-acting tandem types. One of

the advantages claimed in the latter is that in engines having more pairs of cylinders (arranged in tandem) there is one power stroke for every revolution for each pair of cylinders. An interesting feature is the manner in which the compression is maintained in the bottom cylinder. This is effected by means of a water-cooled sleeve, in which the piston-rod (apparently fitted with rings) works. The booklet is extremely well illustrated, containing drawings of these engines in colour, showing most clearly the working parts, system of lubrication, and water services. Much information is given concerning cooling and correct lubrication and the various troubles arising from inefficiency in this respect. A considerable portion is devoted to gas, and the process by which it is made, cleaned, and coloured. Sectional drawings of a blastfurnace installation, suction, and pressure-producing plants are shown, details being given as to the advantages of these plants, and the sizes of engines with which they are most successfully operated. A table is drawn up, giving the comparative heat values in British thermal units per cubic foot of various gases and their relative operating compression per square inch.

The application of oil as a hydraulic medium is well-known amongst engineers, and a suitable transmission by this method would be a great achievement. **The Variable Pumps and Motors Ltd.**, of 222, Great Dover Street, London, S.E., have issued a booklet describing the "Carey" transmission system. This consists mainly of a rotary pump, the rotor having a series of cylinders each containing a ball piston operating by means of centrifugal force, the end of the rotor revolving in contact with a flat valve having two ports. A ring or track working in the casing between guides constrains the motion of the ball pistons, and it is stated that the quantity of the delivery can be varied by the alteration of the position of this ring (which has a screw-adjustment) in relation to the centre of the rotor shaft, insomuch that the direction of the flow can be completely reversed at will. By a modification of the construction, this pump may be supplied with oil under pressure, and power thus derived from it. It will be thus readily seen that such a system would be particularly adaptable to a number of purposes where flexibility of transmission is required, a notable asset being that the whole of the working parts are immersed in oil, thus eliminating lubrication difficulties. Drawings describing the "Carey" transmissions, as applied to the operation of hydraulic lifts and motor-vehicles are given, also details of the construction of the pumps. Figures as to the efficiency of this most interesting apparatus are apparently not given. There is no doubt, however, that it offers immense possibilities, and those interested should communicate with the firm on the subject.

Letters to the Editor.

The Editor will always be pleased to hear from readers who desire to express their opinions upon engineering and kindred subjects. Letters should be as brief as possible and be written upon one side of the paper only. The insertion of a letter in our columns does not necessarily mean that we endorse the opinions expressed therein.

THE A.E.S.D. AND TECHNICAL ACTIVITY.

To the Editor of "The Industrial Engineer."

Sir,—Evidently, "Per Aspera ad Astra," in your issue of the 21st September, had written his letter previous to the last Technical Committee meeting. I believe at that meeting a motion was passed relegating the technical activities of the Branch to a passive existence for the present session. It does not seem to be understood that, to be identified with stars of the first magnitude is to be recognised as belonging to the same constellation. Now, let it be grasped by each member that, according to the abilities of the individual, in just the same proportion will the qualities of the Association as a whole be manifested. This being the case, it is absolutely essential for each member to bring himself to the highest possible pitch of efficiency, and thus make the technical activities—qualitatively—of the Association equal to any other similar body at present existing. Let us be done with mere transient expediencies; a man's life does not consist in the abundance of things possessed. Perhaps a little exercise in introspection would help to discover some startling deficiencies in our intrinsic life, and would act as an incentive to assist those who have laboured abundantly to make the technical side of the Association the stable base for a real status-raising edifice.—Yours, etc.,

Technical.

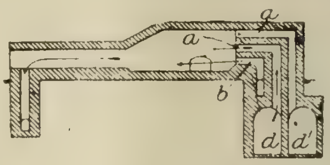
Patent Applications.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

ABSTRACTS OF SPECIFICATIONS.

FURNACES.

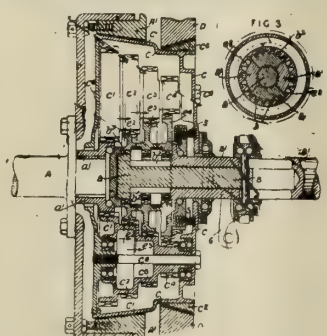
116,870.—E. W. Harvey Gas Furnace Co. and E. W. Harvey, 10, Queen Anne's Gate, Westminster.—March 5th, 1918.—In a reheating furnace of the kind in which the finishing hearth is heated by a reversible flame, and the draught is so controlled that a portion of the gases is drawn continuously along the pre-heating hearth, the air currents only are reversed, the gas being supplied in a number of continuous streams. In one arrangement, Fig. 3, the gas is delivered through a set of ports b in the end wall of the finishing hearth, while the air is supplied from one or other of the regenerators d, d1 through the



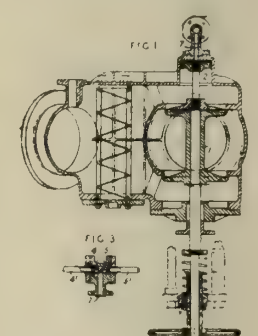
corresponding ports a or a1. The main body of the combustion products escapes through the other regenerator, while the remainder is drawn along the preheating hearth in the usual manner. The air ports may be above the gas ports, as shown or below them, or one set may be above and the other below, or both sets may be between gas ports above and below. The two sets of air ports may be in the same horizontal plane. If a low furnace is desired, the gas ports only are arranged in the end wall, the air being delivered vertically through ports in the hearth. Where the ingots are pushed right through the furnace, instead of being withdrawn through a lateral opening, the gas and air ports are arranged in the side walls of the finishing hearth.

VARIABLE-SPEED EPICYCLIC GEAR.

116,917.—H. Lindblom, 61, Russell Street, Liverpool.—June 22nd, 1917.—In epicyclic variable-speed gearing, a driving sun-wheel gears with a planet-wheel integral with other planet-wheels gearing with a series of lose sun-wheels, any one of which can be clutched to the driven shaft, the planet-carrier being bodily movable to engage either a clutch part on the driving-shaft for solid drive or a brake block for the lower speeds and reverse. The driving-shaft A drives a sun-wheel a1 gearing with a planet-wheel c1 integral with planet-wheels c2, c3, c4 on bolts c6 in a casing C provided with a clutch surface C1 and brake surface C2. The wheels c2, c3, c4 gear with sun-wheels e2, e3, and with an idle pinion gearing with a sun-wheel e4. Normally, springs S press the surface C1 into engagement with an adjustable clutch part A1 secured to the shaft A, so that the gearing rotates solid for high speed. A lever G is employed to disengage the clutch and engage the surface C2 with a brake-block D, when any of the sun-wheels e2, e3, e4 may be connected to the driven shaft B, for two forward speeds and a reverse, by a clutch rod B carrying integral sections fitting segmental slots b2 in the shaft B1 and provided with peripheral teeth b3.



Patent 116,917.



Patent 116,967.

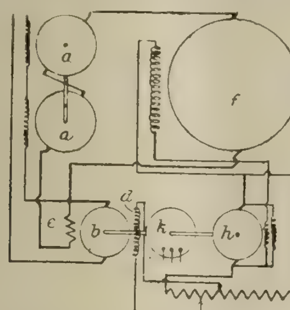
VALVES.

116,967.—Cockburns Ltd., D. Cockburn, and D. MacNicoll, Cardonald, near Glasgow.—August 17th, 1917.—A valve device particularly applicable for use in steam-turbine installations on board ship to prevent steam passing to the low-pressure stages except when the port and starboard main turbines are running both ahead or both astern, comprises a piston-actuated double-beat beat valve 1 controlled by a pair of auxiliary valves 4, 5. These valves, which are arranged in a casing connected to the steam spaces beyond the port and starboard ahead turbine valves and through a

port 7 to the space above the piston 2, are adapted to seat alternately and are only open to admit pressure to actuate the valve 1 when pressure exists in both pipes 4^1 and 5^1.

DYNAMO-ELECTRIC MACHINES.

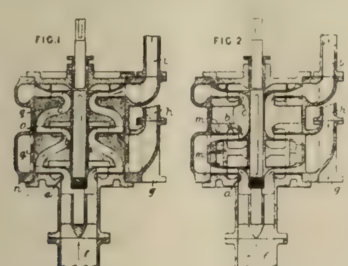
116,915.—BRITISH THOMSON-HOUSTON CO., 83, Cannon Street, London, and A. A. POLLOCK, 75, Hillmorton Road, Rugby, Warwickshire.—June 21st, 1917.—In a system of electric drive for rolling mills in which the mill motor *f* is supplied with current



from a reversible generator *a*, the field of the latter is excited by a reversible exciter *b* having a main field-winding *d* and an opposing field winding *e* excited by current supplied by the generator to the motor. The exciter *b* and the exciter *h* of the motor may be driven by an induction motor *k*. Specification 22817/04 is referred to.

CENTRIFUCAL PUMPS.

116,991.—E. SCHAUFFELBERGER, 119, Kenilworth Court, Putney, London.—Sept. 26th, 1917.—In order to provide for working efficiently against different heads of water, the several impellers of a pump are adapted to be readily removable with the intermediate guide members and replaceable in different manner in order that two or more impellers may work in series or in parallel. Fig. 1 shows three impellers *a, b, c* with guide members

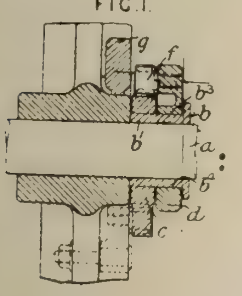


g working as a multistage pump, the suction being from the central pipe *f* and the discharge through the pipe *i*. The second inlet *g* and outlet *h* are stopped by the guide rings *n, o* and the intermediate guides *q, q*1. Fig. 2 shows the impellers rearranged with different intermediate guides *m, m*1, so as to act in parallel, with two suction inlets *f, g* and two discharge outlets *h, i*. If preferred, a different set of impellers may be employed for different duties.

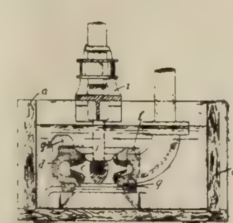
SPEED GOVERNORS.

117,025.—E. Z. HALL, 76, Victoria Street, London.—Dec. 10th, 1917.—A governor for controlling the supply of fuel to an internal-combustion engine comprises weights *g* connected to a ring *c* revolubly mounted on a circular part *b*1 of a member *b* keyed to the shaft *a*. The ring *c* is connected by a pin *f* and slot to an eccentric *d* slidably mounted on two flat faces *b*3, *b*4 on the member *b*, so that when the ring *c* is angularly displaced, by the centrifugal action of the weights *g*, the eccentric is moved transversely of the shaft *a*, and its eccentricity varied, thereby varying the stroke of the fuel pump.

FIG.1.



Patent 117,025.



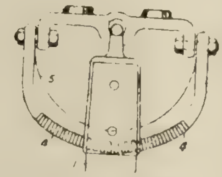
Patent 117,145.

CENTRIFUCAL PUMPS.

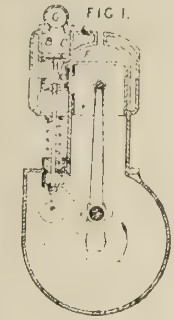
117,145.—R. STEWART, 46, Westbourne Road, Luton, Bedfordshire, and M. ALLEN, Elsinore Road, Old Trafford, Manchester.—July 13th, 1917.—A pump for raising corrosive liquids comprises a casing *d* supported on a stand *g* on the bottom of a tank *a* containing the liquid to be pumped. The upper member *f* of the casing is secured in place by extensions *g*2 of the stand. The impeller *c* runs freely without packing or glands in the casing, being suspended on a shaft *j* carried in a bearing *i* which is clear of the liquid. All parts in contact with the liquid are made of non-corrosive material.

INTERNAL-COMBUSTION ENGINES.

117,050.—T. D. TAYLOR, 19, Springwell Place, Dalry Road, Edinburgh.—March 6th, 1918.—A beat or lift valve C is mounted in the interior of a cam-actuated piston valve B which controls an inlet and outlet port F in the cylinder wall. Charges are admitted to the cylinder through a port X in the piston valve after having traversed an opening controlled by an automatic lift valve C. The combustion gases escape through a pipe G when the piston-valve uncovers the port F.



Patent 117,031.



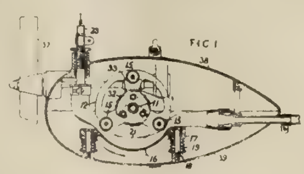
Patent 117,050.

BELT CEARING.

117,031.—H. BUTLER, H. BUTLER, and R. H. HAYHURST, Victoria Ironworks, Halifax, Yorkshire.—Dec. 29th, 1917.—A lever for operating a device for moving a driving-belt on fast or loose pulleys is formed with rack teeth engaging teeth 4 on a fixed bracket 5. The lever 1 is automatically locked in its two positions and is released by drawing it slightly forward.

ROTARY PUMPS.

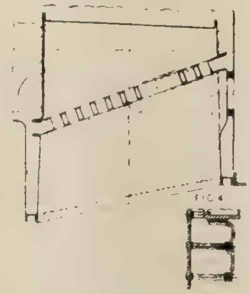
117,110.—T. B. JONES, 2, Morley Road, Lewisham, London.—Dec. 21st, 1917.—In pumps of the kind comprising a collapsible elastic tube adapted to be pressed at successive points against an abutment by a continuous series of movable external members travelling lengthwise of the tube, the pressing members consist of a series of anti-friction rollers 15 carried at equal angular dis-



tances apart between a pair of rotating disks 12, the collapsible tube 21 is coupled to the delivery pipe 23 by a device which allows the end of the tube to rise and fall, and the abutment 16 consists of a plate curved about the axis of the disks and formed at its ends with apertured bosses 17 which slide on studs 18 and are pressed towards the axis 11 by springs 19. The discs 12 may be driven by an aeromotor 37 through worm gearing 33, 32. The whole apparatus is enclosed in a two-part casing 38, 39, and may be used on aircraft for pumping petrol.

STEAM CENERATORS.

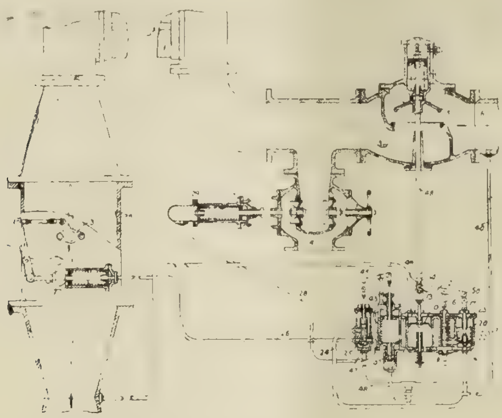
117,152.—G. GILLIES, 44, Buckingham Place, Brighton.—July 24th, 1917.—The plates of a water-filled partition 6 extending diagonally



across a locomotive fire-box and having openings 7 for the passage of the furnace gases on their way to the fire-tubes are so joined to the fire-box plates by means of flanges 12 extending into the boiler water space that the joints are not exposed to the destructive action of the furnace gases. The fire-box plates are dished externally to receive the screwed conical ends 15 of the stays.

COVERNING TURBO-COMPRESSORS.

117,028.—FRASER and CHALMERS, Moorgate Hall, Finsbury Pavement, and B. F. POCHOBRADSKY, 55, Cleveland Square, Lancaster Gate, both of London. Dec. 14th, 1917.—Pulsation in a turbo-compressor or turbo-blower is prevented by a throttle valve on the intake and a relief valve on the outlet which are operated in accordance with the mass of gas passing through the compressor, the throttle valve being operated first as the output falls, followed by the relief valve. A Venturi nozzle 2 is arranged in advance of the throttle valve 3 in the intake of a compressor 1, and a relief valve 4 and non-return valve 5 are arranged in the outlet.



A piston 10 is subjected on one side to the pressure of the Venturi nozzle and on the other to the pressure in the pipe before the nozzle which, in the arrrangement shown, is that of the air. A lever 12 is pivoted to an extension 14 of the piston-rod and to it are pivoted a link 16 connected to a relay plunger 18 and a link 17 connected to a piston 19 movable in a cylinder 20 under the control of a spring 23. On downward movement of the piston 10, owing to decrease of the mass of air passing through the Venturi nozzle, the lever 12 turns about the pivot 50 and depresses the plunger 18 which admits, to the lower surface of the piston 19, fluid under pressure supplied from a pipe 22 to the plunger chamber. The piston 19 thereupon rises and the link 12 turning about the fulcrum 13, the relay plunger is lifted. The lower part of cylinder 20 is connected by a pipe 24 with a distributor 25 normally in communication by pipes 26, 28 with cylinders 27, 29 which operate the throttle valve 3 and the relief valve 4. The pressure of the controlling springs 37 is adjusted so that the valve 4 is opened after the throttle valve has been partly closed. A non-return valve 5 in the outlet completely closes when the supply of air is reduced below a certain limit and at this stage the valve 4 is fully open and the valve 3 closed to an extent limited by a stop 39 allowing a small quantity of air to pass. If the demand for air is increased, the pressure in the outlet 6 will fall and this reduction communicated by a pipe 40 to the underside of a piston 41 allows the piston to be moved by a spring 43, the motion being communicated by a link 45 to a piston valve 47 forming part of the distributor. As the piston valve 47 rises, the pipe 26 is connected to a drain 51 and the valve 3 opens. The valve continues to rise and connects the pipe 28 to the drain, whereupon the valve 4 closes and the pressure rising on the outlet side of the compressor the non-return valve 5 is opened. The stem 48 of the valve 5 is connected to the stem of the piston 10 so that, if by a sudden closure of the delivery main pumping is set up, the piston 10 will be forced downwards and the valves 3 and 4 operated. A slot 49 allows the piston 10 to operate normally when the valve 5 is open.

INTERNAL-COMBUSTION ENGINES.

117,155.—J. A. TORRENS, Moylena, Muckamore, Co. Antrim.—July 25th, 1917.—An exhaust-heated vaporiser comprises a chamber *a* having a combustible mixture inlet *b* and an outlet *c* and surrounded by a jacket *e* formed by a casing *d* fitted to the exhaust pipe 6[1]. The chamber has external flanges 6 and internal horizontal and vertical flanges *h, k, j, m.* Unvaporised fuel collects between ribs 2 in the base of the chamber *a*, any surplus over-

FIG. 1

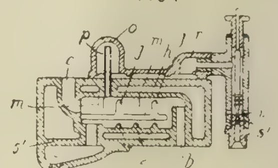
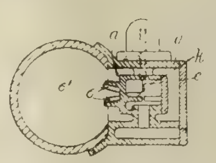


FIG. 2



flowing into a heated catch chamber 3 provided with air-inlet holes 4. With increase of suction, such fuel is drawn against the hot plate 5[1] and is vaporised. Steam may be admitted to the chamber *a* by a pipe *p* extending into a dome *o* connected to a heated chamber *n* which is supplied with air and water through holes *w* and needle valve *s*[1] respectively. In a modified construction, no steam is admitted, air only being supplied by the chamber *n*, and a wick is disposed below the flange *h* to absorb and facilitate vaporisation of the liquid fuel. Specification 15825/15 is referred to.

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CONTENTS.

EDITORIAL.

INDUSTRIAL CHANGES.

SEVERAL public men have dealt at length with the reconstruction of the world of labour, and some very revolutionary ideas have been seriously advocated. Whether industry can afford the new conditions is perhaps debatable, but that there is intrinsic interest in the proposals cannot be denied. Large employer and scientist, economic expert and trades union official, the Government itself—is there not a Ministry of Reconstruction—all are endeavouring to hammer out a new industrial polity and re-assemble the components of the industrial machine to give harmonic motion, reduce friction to a minimum, and find a new basis for the future. Never in the history of industry has there been the same consensus of deliberate opinion that radical change is not merely necessary, it is unavoidable. Prominent among the proposals is that for a six-hour working day; it is not so much a high rate of pay, desirable though this may be in terms of a standard of life, as the need and desire for leisure. There is a new conception of work dawning, coupled intimately with the newer methods for speeding up output and minimising waste. No man grudges going all-out in a real emergency, rescue work in mine and conflagration, on board ship, to save life; these all stimulate intense endeavour, irrespective of rate of pay. Appeal to any of the finer human motives, courage, bravery, helpfulness, and the results are admirable. Appeal to cupidity, knavery, individualism, and exploitation is rampant. The average normal man is not envious of the rare and curious, he only wants a decent life with certain ameliorations and advantages, which he rightly believes he should share in common with the mass of mankind. The operative is told on good authority that the introduction of steam, known as the industrial revolution, multiplied human wealth in a manifold degree, and he is of the distinct opinion that its advantages are reserved for a limited number. He will say that he still finds it difficult to live, rear a family and be a decent citizen.

To a very great extent, this is what underlies all forms of industrial unrest; resentment at the fact that out of the creation of modern credit, with its immense advantages, his share is less than fair. It is useless to preach thrift to the average labourer, for his wage does not permit of its practice. Even the skilled mechanic on weekly or hourly rate cannot without great effort contrive to be thrifty, and in any case economic independence, however diligent he may be, is a sheer impossibility. The works official, foreman, manager, commercial man, clerk, draughtsman, technician, all those whose efforts underpin industry are virtually in like case. Knowing the penalty inflicted upon the untrained and unskilled, they sacrifice a great deal that their progeny shall have a good start. The economies and self-denial practised by the latter class is undeniable. The pinching and scraping, the denial of those things which enrich and adorn life is very real, very stringent. In fact, practically all classes in the community to-day are convinced of the need for giving the promising youth its chance in life, while the older generation suffer to make this possible.

There are cases within the writer's personal knowledge where a man having reasonable hours in one employment follows a second, simply in order to live and rear a family in decency, which his standing wage is unable to afford. It is not greed, it is simply

a rightful aspiration after a better existence, purchasable only by sacrifice of leisure, a circumstance galling in itself. Even the man who pits high intelligence, great endeavour, long training and powers of mind against the barriers imposed by circumstance is apt to find that his reward is proportionately so small that it is questionable whether it was worth making.

The conditions are common to industrial pursuits, where supply and demand fix salary. Can it be wondered at, therefore, if industry needs a new stimulus, for the classes affected are vital to its well-being.

The mission of mechanism is very high, its ultimate outcome should render degrading toil obsolete. If it has a purpose at all, the machine should duplicate men, making it possible for one man to perform the work of several. The more mechanism is extended the greater the total wealth; in place of winning nature's reserves with painful and difficult hand means, the machine enables one brain to win great quantity at the minimum of effort.

To counteract the beneficent operation of the extension of power, labour has combined, made conditions and regulations that the ultimate efficiency shall be lowered. In effect, the restrictive practices are a protest that labour's reward is limited. For some occult and mysterious reason the employer will not allow really high wages even when earned on a production basis, if the former price carried a commensurate profit, the higher the earnings the greater the total paid to both. Seeing that he is virtually forbidden to earn high payment, the man restricts his efforts and industry and the national interests are less prosperous thereby.

To restore prosperity needs a new point of view whereby man and management agree to co-operate to the desired end. A man is human and desires not to work for the sake of work; he works to win freedom, the measure of his wants is the measure of his effort. Wants, however, totally out of reach are no incentive, and a working day which leaves neither leisure nor energy at its end, for bare subsistence payment, will not make for first-class work, for it creates inferior men. Every man requires two occupations, one to give him subsistence, the other to give him interest after his own heart; where these coincide, the circumstances are happy, but in the majority of instances for well-known reasons such an end is impossible.

A man with very little leisure is going surely to abuse what little is at his command, he seeks excitement and vicious reaction to offset monotony. After all, wealth is merely command of leisure, it certainly is more this than purchase of material things.

From an industrial point of view, always premising that the economic viewpoint allows it, a six-hour day is worth while. The alternative of work-round-the-clock without cessation by means of four six-hour spells without break, all hands putting real effort into the job, is rather attractive. Many utility services now work three shifts: there is the precendent of navigation, police, and others. With one complete twenty-four hour break in the week, the remainder of the time would see plant, buildings, power in continuous operation and the overhead expense reduced to a minimum. The suggestion is better than the retention of normal hours and a five-day week, though this latter alternative has numerous advocates.

After all, we have each only one life to live, and at present it gives very scant leisure to most of us. The flaw at present is the overhead national expense which must be met if the State remain solvent. But even this is not impossible, nor are reasonable profits and dividends upon capital ruled out by the proposals. True, potential credit will not accumulate quite so fast, but this is a check upon misuse of the common creation of wealth. Extension of power in emergency is given by normal short hours, the total labour can be increased at demand, provided always it is for some common purpose and not for private benefit.

In any event, men whose word carries weight in industry have stated the proposals to be practical, and provided that the men of toil agree to remove restrictions and win the gift of leisure by real effort, and that the two sides to the equation of production co-operate to a single end, a great deal otherwise impossible becomes practical politics.

CONCRETE VESSELS IN COLLISION.

Inquiry is occasionally made by those considering the adoption of ferro-concrete ships as to the probable effects of a collision between two such vessels. The same question might just as well be raised concerning steel ships, but is perhaps unnecessary, as the disastrous effects of a collision are already well known. Those who put the question with regard to ferro-concrete, may possibly think that the colliding hulls would be hopelessly smashed like two earthenware vessels. Any such idea would be quite a mistaken one, as shown by the extraordinary resistance of ferro-concrete to artillery fire, the highly satisfactory behaviour of ferro-concrete armour for warships in tests conducted by the Italian Government, and numerous other demonstrations of the great toughness and cohesion of the material.

The only actual instance on record at present of a collision of two concrete vessels is one furnished last year during the flooding of a dock basin at Balboa, on the Panama Canal. It is recorded that after the blowing up of the coffer-dam used in constructing the basin, a powerful current was established, breaking from their moorings two concrete pontoons, 120 ft. long by 28 ft. beam, which circled about the basin and collided violently, but without suffering any damage.

Discoveries of Ore in the Celebes.- According to the Dutch papers, news to hand from Soerabaya state that very rich finds of ore have been made in the Verbeck Hills at Celebes; the prospecting made there is reported to have given very astonishing results. At first it was estimated that the beds contained about 350 million tons of iron ore, but now it is stated that there are at least 1,000 million tons of laterite iron ore. Outcroppings showing 25 per cent nickel have also been found over an area of from 300 to 400 kilometres. They are most favourably situated, both for working and for transport purposes. The ores lie at a depth of from 14 to 15 metres. Iron ores, chrome iron ores, nickel and manganese are also found in this district.

GOVERNORS AND GOVERNING MECHANISM.

By A. HOULSON.

(Continued from page 25.)

Crankshaft Governors.

We have already shown some illustrations of crankshaft governors in Figs. 7, 8, and 9 in order to explain clearly the principle of inertia. As the name implies, these governors are fixed directly on

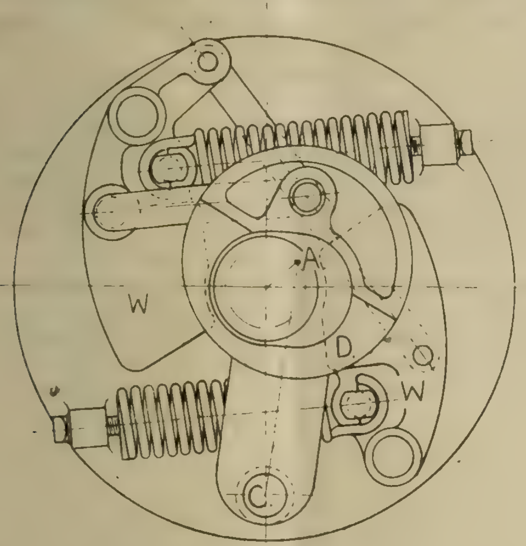


FIG. 32.—GOVERNORS.

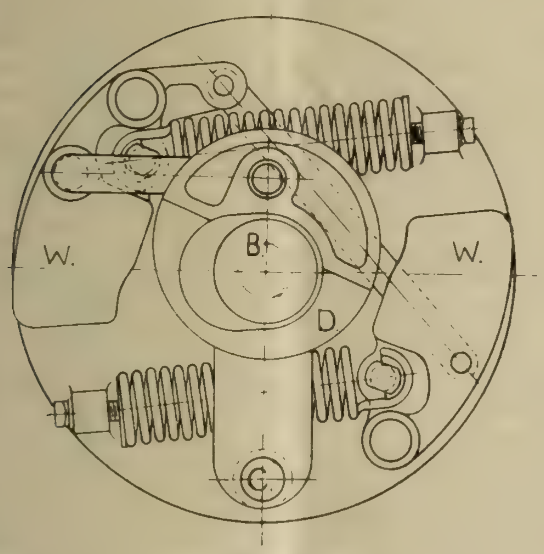


FIG. 33.—GOVERNORS.

the crankshaft without the intervention of gearing. Generally speaking, it is not advisable to fit these governors on engines running less than 180 revolutions per minute, because they become so bulky, the weights being made large to obtain the necessary controlling force.

Figs. 32 and 33 show the Westinghouse crankshaft governor, Fig. 32 with weights at "in" position, and Fig. 33 with weights at "out" position. The eccentric D is pivoted at C, and when the weights move outwards they draw the eccentric across the shaft from A to B as shown, causing both cut-off and lead to vary.

In most of the governors previously shown, the arrangement of the springs is such that the load comes on the fulcrum pins, resulting in considerable friction. In the shaft governor shown in Figs. 7 and 8, and in the Hartung governor Fig. 27, where the springs are connected across from weight to weight, this objection is overcome.

In certain cases, it is desirable that the governor should be capable of being readily altered to suit a reverse direction of rotation. The one shown in Fig. 9 permits of this; all that is necessary is to change over the end A of top link to pin B, and the end C of bottom link to pin D. Table 5 gives dimensions of these governors.

In Fig. 34 is shown a method of obtaining the centre of gravity of an irregularly-shaped weight, such as are used in shaft govenors.

Two datum lines are taken, and the weight divided up into (1) horizontal strips, and (2) vertical strips.

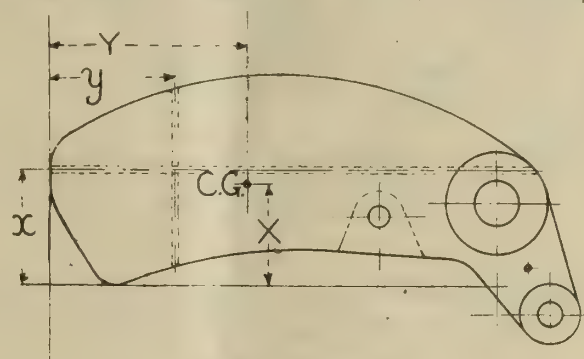


FIG. 34.—GOVERNORS.

Starting with the horizontal strips, the volume of each strip is multiplied by the distance x of its centre from the horizontal datum line; thus obtaining a moment. The sum of the moments, divided by the total volume, gives the distance X of the horizontal line on which the centre of gravity lies from the horizontal datum line.

Similarly, the distance Y of the vertical line on which the centre of gravity lies from the vertical datum line can be found. The intersection of the two gives the centre of gravity of the weight. The

TABLE 5.—CRANKSHAFT GOVERNORS.

Diam. Crank Shaft.	Max. Travel Ecc.	Outside Diam. Casing.	Over-all Length.	Diam. Ecc. Sheave.	Width Ecc. Sheave.	Diam. Piston Valve.
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
2½	1¾	16¼	8¼	6¼	1 11/16	2¼
3	1⅞	16¼	8¼	6¼	1 11/16	2½
3½	2¼	19	9¼	7	2	2¾
4¼	3	22¼	10½	9	2½	3
4¾	3¾	26¼	13	10	2¾	3⅜
5½	4⅞	29½	15	12	3¼	3¾

Dimensions in inches.

weight should be symmetrical about its centre line in plan.

If, in addition to being symmetrical in plan, it is also of uniform cross-section, then the ordinary method of balancing a cardboard sheet of the same shape as the elevation of the weight is sufficiently accurate.

The governor of Figs. 7 and 8 operates the throttle valve shown in Fig. 35. "A" is the malleable-iron governor plate, keyed to the shaft, and upon which are cast lugs carrying the weight lever

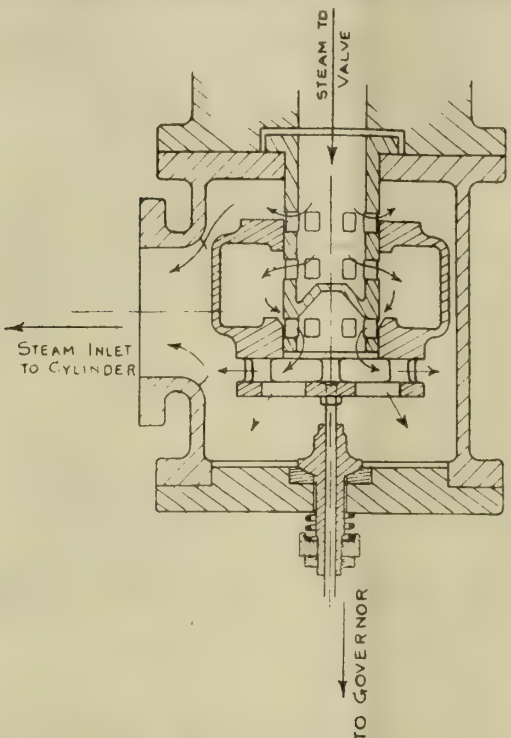


Fig. 35.—Governors.

spindles C. These spindles are provided with a peg to prevent them from turning round, and the cast-steel weight levers B are pivoted on the spindles. The horizontal arms of these levers are fitted at the outer ends with the pins D, which are attached to the main governor springs E. This arrangement relieves all other pin joints of any strain due to the centrifugal force of the governor weights. The device of tension screws F and spring shackles G enables the springs to move in a straight line, although the pins D move in an arc. The springs are attached to the weight levers by knife-edge joints, so that the governor can be made very powerful, and at the same time very sensitive. All the working joints other than knife edges are under forced lubrication. The vertical arms of the weight levers are fitted with hard steel dies H, which actuate a cast-iron sleeve J sliding laterally on the engine crankshaft. The dies are provided to take up the "slotting", or rubbing motion, which is unavoidable at this point. The sleeve should be long enough to avoid any possibility of tilting on the crankshaft. It is fitted with a feather key K, to keep it in its proper angular position relatively to the weight arms whilst rotating with the shaft.

At the other end of the sleeve a trunnion ring L (in halves) is held in a stationary position between two collars formed on the sleeve. Some makers provide a loose collar at end of same, but with such an arrangement there is always a tendency for the collar to work loose. On the face of the collar receiving the thrust due to the pull in main springs is formed an eccentric groove. The object of this groove is to entrap the oil and distribute it to all parts of the wearing face, the oil being fed under pressure through a hole in the centre of the crankshaft into the annular space contained between the bore of the sleeve and the circumference of the crankshaft, passing from thence to the working faces.

The trunnion ring is held between the jaws of the forked arm of the bell crank lever M, thus communicating the motion of the sleeve to the throttle valve. Suitable stops are provided on the governor plate, as shown at X and Y in Fig. 8, and limit the movement of the governor weights, and, in turn, that of the governor sleeve, in both directions. When the engine is at rest, these stops directly relieve the various parts of the governor from any strain due to the initial load on the governor springs.

The arrangement of the speed-adjusting spring is shown at Z. This spring must act in opposition to

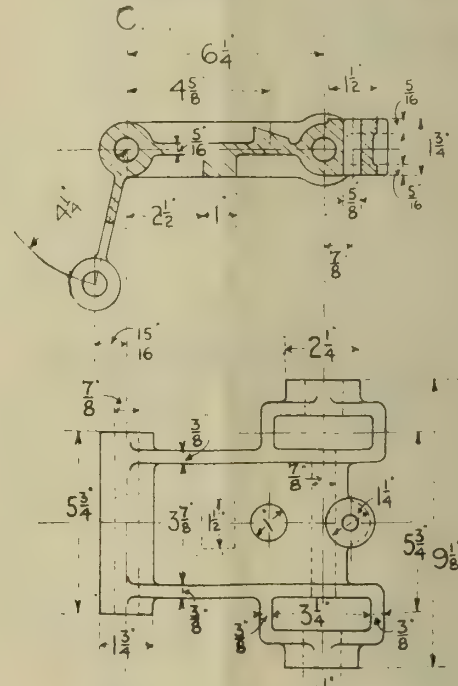


Fig. 36.—Governors.

the movement of the governor weight levers, which tend to fly out and close the throttle valve; that is, it must tend to force the throttle valve open.

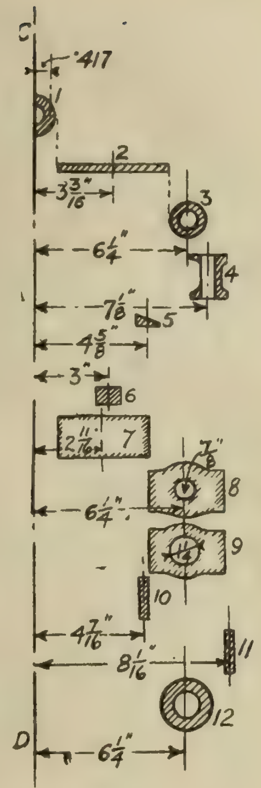
Incidentally, this spring provides an initial thrust on the various pin joints, thus taking up any play. All the rotating parts of the governor are in balance, thus eliminating vibration. This has necessitated the duplication of projections, lubricator fittings, etc. The inertia arm N has already been discussed, and needs no further reference.

It is sometimes a convenience if the flexibility of

TABLE 6.

Part No.	Description.	Volume in Cubic Inches.		Arm in Inches.	Moment.
1	One Half Ring.	$(1 \cdot 2 - \cdot 3)\ 5 \cdot 75$	$= 5 \cdot 16$	·417	2·155
2	One Web.	$4\tfrac{5}{8} \times 3\tfrac{7}{8} \times \tfrac{5}{16}$	$= 5 \cdot 6$	3·1875	17·8
3	One Ring.	$(1 \cdot 76 - \cdot 6)\ 3 \cdot 875$	$= 4 \cdot 5$	6·25	28·1
4	One Boss.	$2 \times \cdot 3125 \times (1 \cdot 76 - \cdot 3) + \tfrac{2}{3} \times 1 \cdot 125 \times (1 \cdot 23 - \cdot 3)$	$= 1 \cdot 614$	7·125	11·48
5	One Stop.	$\cdot 7854 \times \cdot 375$	$= \cdot 294$	4·625	1·36
6	One Stop.	$1 \times 1\tfrac{1}{2} \times \cdot 719$	$= 1 \cdot 075$	3	3·22
7	Two Plates.	$2 \times 3\tfrac{7}{8} \times 1\tfrac{3}{4} \times \tfrac{3}{8}$	$= 5 \cdot 1$	2·688	13·7
8	Two Plates.	$2 \left\{ (3\tfrac{1}{4} \times 1\tfrac{15}{16} \times \tfrac{3}{8}) - \cdot 6 \right\}$	$= 3 \cdot 52$	6·25	22
9	Two Plates.	$2 \left\{ (3\tfrac{1}{4} \times 1\tfrac{15}{16} \times \tfrac{3}{8}) - 1 \cdot 23 \right\}$	$= 2 \cdot 26$	6·25	14·1
10	Two Plates.	$2 \times \tfrac{3}{8} \times 1\tfrac{1}{2} \times 1\tfrac{3}{4}$	$= 1 \cdot 96$	4·4375	8·7
11	Two Plates.	$2 \times \tfrac{3}{8} \times 1\tfrac{7}{8} \times 1\tfrac{3}{4}$	$= 2 \cdot 46$	8·063	19·8
12	Two Rings.	$2 \left\{ (3 \cdot 98 - 1 \cdot 23) \times \cdot 75 \right\}$	$= 4 \cdot 12$	6·25	25·8
		Total	37·663	..	168·215

Arm 4·46.



the main springs may be altered. In this governor, this may be accomplished by winding the shackle G around the coils to any desired extent.

The governor weight lever B is shown to a larger scale in Fig. 36, and the method of determining the centre of the horizontal arm of the lever is shown in Table 6. The metal is arranged equally at each side of the centre line A B in plan, and is also symmetrical in elevation, thus ensuring that the centre of gravity shall lie somewhere on the line A B in both views. To obtain its exact position, proceed thus: Take any datum line C D at right-angles to the centre line A B, as shown in the table. Divide the weight arm into 12 parts, and obtain the number of cubic inches in each part. Write these down in the third column. Also measure the perpendicular distance from the datum line C D to the centre of each part. These values are enumerated in the fourth column. The product of the volume of any part multiplied by its perpendicular distance from the datum line is the moment of that part. The fifth column is the column of moments. Totalling up the third and fifth columns, and dividing the latter by the former, gives us the distance of the centre of gravity of the arm from the centre line C D.

(To be continued.)

Aircraft Company's Success.—In a letter just issued to the shareholders of Whitehead Aircraft (1917) Limited, Mr. J. A. Whitehead, governing Director, intimates that the preliminary figures for the year ending September 30th, 1918 (after making ample allowance for depreciation) show that the preference and ordinary dividend has been earned some three times over.

BUYING A SECOND-HAND STEAM ENGINE.

By Edward Ingham, A.M.I.Mech.E.

(Concluded from Vol. VI., page 449.)

It has previously been explained that whilst wear of the different parts of an engine does not appreciably effect the strength of the engine, it is, nevertheless, a factor to be reckoned with in judging the condition of an engine. Hence, whilst in making the examination, the discovery of fractures is of the first importance, every attention should be given to the condition of the engine as regards wear.

Wear in the Cylinder.

There is probably no part where wear is liable to have a more serious effect than in the cylinders. As already pointed out, if the cylinder walls and the valve seats are much worn, serious loss by leakage of steam will result. A very careful examination of these parts should therefore be made. Frequently, the cylinder walls are badly cut and scored, and the grooves so formed provide small openings for the escape of the steam. Even if the walls appear to be in good condition, they may, particularly in horizontal engines, be worn oval, owing to the constant rubbing of the piston rings over them. The bore should, therefore, be carefully calipered at a number of places with a view to detecting the amount of wear which has taken place. If, of course, the wear is serious, or if the walls are cut and scored, re-boring of the cylinder will be required, but it will be necessary to ascertain whether or not there is a sufficient thickness of metal to allow of such re-boring being done without weakening the cylinder to a serious extent.

Valves.

The valve faces and the valves should be carefully inspected for signs of wear and scoring. Large flat valve surfaces, such as those met with in slide-valve cylinders, frequently wear irregularly and are responsible for much loss by steam leakage. A straight-edge will be found useful for testing the faces. When the valves are of the Corliss or other type, it is a difficult matter to ascertain whether or not the valves are tight, merely by inspection. Generally, the best plan of testing the valves is to do so by actual steam testing, the valves being placed in their proper position and care being taken to prevent the possibility of the engine's moving off. The piston also is best tested in the same way. If the valves are of the piston type, it is advisable to have them withdrawn, so that a satisfactory examination can be made. The rings frequently become badly worn and give rise to considerable leakage.

The Piston Rod.

The piston rod, also, should be examined for scoring and wear, and tested for being straight and true. Only a slight amount of scoring may lead to considerable leakage past the stuffing box gland. The same thing applies in a lesser degree to the valve spindles. In the case of Corliss valve spindles, the motion is rotary instead of reciprocatory, and the spindles are commonly neglected and become badly scored and worn. The scoring in this case, of course, takes place in a circumferential instead of a longitudinal direction.

Examine the Bearings.

All bearings and pins will require examining for signs of wear. Worn brasses are a common cause of knocking, and for this reason alone require replacement unless the wear is only slight. It is well to bear in mind that pins often wear slightly oval, and all large pins should consequently be gauged. Any pins which are found to be at all oval may be looked upon as useless until they are trued up, because satisfactory working cannot be expected unless the pins are truly round, no matter how good may be the condition of the bearings.

Slackness about the joints of the governor rods and links should be particularly looked for, since such slackness may lead to unsatisfactory governing. Whilst examining the governor gear, it is well to look at the bevel wheels which drive the governor for damaged or broken teeth.

After completing the examination, the intending purchaser should make a point of seeing if the engine is provided with suitable draining arrangements, cylinder escape valves, indicator cocks, etc.

A drain tap and an escape valve should be provided for each end of the cylinder. Preferably, the drains should be connected with a steam trap, so that the water which forms in the cylinder may be drained off as fast as it is formed. It is important that the drain taps should be of ample size. Taps of small bore are soon choked up, in which case they become a source of danger. The bore should in no case be less than ¾ in.

We have now dealt with the principal points which should receive attention in the examination of a second-hand steam-engine, but it must be understood that there are many other points which might be dealt with, but which cannot be owing to limitations of space.

Engine Power.

One more question must, however, be referred to, viz., the question of engine power. The intending purchaser must know with certainty what power he requires, and also the power of the engine he proposes to buy. (The latter may be worked out from the full load indicator diagrams, or it may be computed more or less satisfactorily in other ways.) The important point is to avoid purchasing an engine which will be much too large for its purpose. Such an engine is extremely wasteful in steam, and at the present time especially, when the cost of coal is so great, the installation of an unnecessarily large engine would be a great mistake. A boiler too large for its work may be worked economically on the slow-combustion principle, but in the case of a steam engine, nothing can be done to effect reasonable economy.

An examination carried out on the lines suggested will serve to give a good idea as to whether or not the engine is worth purchasing. In most cases, it will be found necessary to execute certain repairs in order to put the engine into satisfactory working condition, and the cost of these will be an important factor in deciding whether or not the engine is worth purchasing. In addition to this, the cost of dismantling the engine, removing it to its new site, and erecting it will have to be taken into consideration.

Finally, we would again refer to the importance of ascertaining the length of time the engine has worked, and whether the parts are unduly stressed or not. No matter how saisfactory the condition may appear to be, it is unwise to make a purchase if the engine is of considerable age and the stresses at all high, because of the possibility that certain parts are seriously weakened by fatigue.

(Concluded.)

THE GAS INDUSTRY AND PUBLIC SERVICE.

AT the seventh annual general meeting of The British Commercial Gas Association, held at the Royal Society of Arts, John Street, Adelphi, W.C. 2, on Wednesday afternoon, October 16th. the President, Sir Hallewell Rogers, J.P., in introducing the incoming President, Lord Moulton, P.C., K.C.B., F.R.S., Director-General of Explosives Supplies, said that apart from its prompt action in meeting the need for explosives in the early days of the war and in releasing men for the fighting forces, and experts for the laboratories, the gas industry had done invaluable work for the country in the quick improvisation of depots, canteens, hospitals and other establishments for the militant army, and of factories and workshops for the industrial army. It had set itself to providing fuel oil for the navy ; had furnished the farmer with cheap and indispensable fertilisers ; had been an important source of ammonia supply ; and last, but not least, had furnished enormous supplies of gaseous fuel to munitions works of all kinds, as well as in increasing quantities to all branches of industry and to the homes of the people.

BOYS' WELFARE ASSOCIATION.—Mr. Will Thorne, M.P., and Mr. W. H. Hutchinson, vice-president of the Labour Party, have consented to join the Council of the Boys' Welfare Association, 33, Tothill Street, Westminster, S.W.

A GERMAN OIL SUBSTITUTE.

Prof. Dr. Karl Goldschmidt, of Essen, and Mr. Robert Friedlaender, of Berlin, both members of the recently formed "Kohlchemie Konsortium," have recently issued a pamphlet calling attention to the advantages and possibilities of their so-called Coal Liquefaction Process, *i.e.*, the synthetic manufacture of benzines, lighting, engine and lubricating oils from lignite, generator tar, crude oil and crude oil derivates. They mention the cracking and separation processes of Zern, Walther and Graele, whereby the constituent parts of tar boiling at higher temperatures are transformed into benzines; they also deal largely with the somewhat closely related Bergin Process whereby, with the aid of heat and hydrogen, there are obtained from tar, benzine and lighting oils of a quality equal to those obtained from natural sources. The chief primary raw material, lignite tar, can be obtained from the heating of generators, for instance, in lignite briquette factories (in which some 20 million tons lignite are worked up), glass kilns, paper mills and the like in which some 12 million tons are used to fire the boilers instead of being gasified. In this way alone 1½ million tons of tar could be obtained for distillation, etc.; even the gasification of lignite alone would suffice to supply Germany with all her requirements in enriched oil products. Until such gasification plant has been established everywhere, steps should be taken to secure a steady importation of raw oil, and more especially of raw materials for the synthetic manufacture of benzine and oil. Such a raw material is the so-called "Petroleum-Gudron," which is a by-product in Russian, Roumanian and Galician distilleries, which use large quantities of it as an inferior kind of fuel. The Government, it is urged, should fix the prices of all synthetic manufactures for some years to come; meantime the erection of factories should be pushed on with, so as to render Germany more independent of foreign countries and also enable her to do a large export trade in such products which could easily be made a monopoly. It is said that the Government is willing to go into the matter and to introduce also an import monopoly of all raw oil products. The "Kohlchemie Konsortium" has a capital of Mk.30,000,000.

METAL SUBSTITUTES IN GERMANY.

By Our London Correspondent.

The German Press has been publishing articles about a series of metal substitutes which England's blockade has forced Germany to invent, a problem—it is jubilantly claimed—which has been very successfully solved. Naturally, papers have not been allowed to publish exact details; still some very interesting data are given, the chief of which we reproduce below.

Germany has been compelled to rely upon her coal, iron and zinc in order to replace the copper, tin, nickel and other metals she used to import in pre-war days. Having been isolated by the blockade, only three ways presented themselves of adapting these scanty means to her needs: (1) a rigorous economy of stocks, (2) the use of substitutes, and (3) the manufacture of metal goods according to the conditions of the time. These three methods were, as a matter of fact, duly adopted.

The electro-technical industry suffered severely from the scarcity of copper and, like the metallurgical and ship-building industries, has had to content itself with zinc alloys containing from 4 to 5 per cent copper or else 2 to 3 per cent aluminium. In railways and tramways iron has taken the place of copper for making door handles, window fastenings, brakes and the like. Zinc has also been used in place of copper, and also nickel, for making buttons and other parts of military equipments. Prior to the war the optical industry only used brass and aluminium, but to-day, instead of the latter, an alloy of magnesium and aluminium called "electron" is used which is claimed to be lighter yet stronger than aluminium. The manufacture of watches, clocks, cutlery, tools, etc., has also been seriously impeded by the scarcity of metal. The cessation of these industries, which give employment to thousands of Germans, spelt "social danger," so it was absolutely necessary to find good substitutes. In the first place these articles were plated with copper and brass to enable them to retain their former appearance. This expedient, however, was soon found to be impossible, and buyers had to be satisfied with the field-grey colour.

Some good substitute for tin soon became also of urgent necessity, especially for the manufacture of munitions, which would have come to a standstill had not the situation been saved by an alloy of zinc and alloys of zinc which are fully equal to brass. For soldering purposes cadmium has been found an efficient substitute, but in order to save this as far as possible a freer use is being made of rivets. The scarcity of brass has also hampered the production of scientific and technical instruments, tools and the like, and no time nor money has been spared in order to reorganize the whole industry and adapt it to actual conditions. Considerable success has been attained, and many of the substitutes discovered will be maintained after the war. Generally speaking, a much freer use has been made of iron, but brass has been the chief substitute. Plates, discs and tubes of zinc are largely used and, in special cases, certain alloys of zinc which are fuly equal to brass. In many cases zinc surfaces have been covered with brass and nickel and, since the latter has got scarce, cobalt; at first the articles thus made had a fair polish, but now they are dull, field-grey and even black in colour. It has, however, not always been possible to replace certain metals imported before the war by others, notably in the case of gauges, compasses, measuring instruments and others that have to be exposed to atmospheric influences.

In the electro-technical industry use is now being made of iron or zinc feed-wires insulated by means of artificial silk or paper soaked in an insulating medium.

Truly, when Germany committed the "mad-dog-in-the-village-act" she little foresaw the straits to which she would be reduced—straits that will not fail to increase in proportion to the growth of her blinded obstinacy.

THE ROSS LOCKNUT.

[Messrs. Lewis and Sawyer Ltd., 8, Bush Lane, Cannon Street, London, E.C.]

The old makeshift devices for locking a nut, such as slotted nuts with spring pins or spring washers, are unfortunately still in fairly considerable use, although efficient devices have long been available. Due to the makeshift devices of this character, accidents and troubles in machinery are frequent.

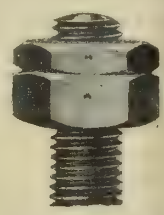
A

B

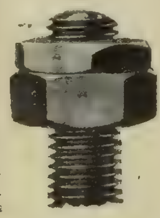
principle and is a novel and efficient method of uniting the two sections. Figs. A and B show the formation of the male and female eccentrics, Fig. C shows in section the uniting of the two eccentrics, Figs. D and E show the locknut locked and unlocked.

A new type of locknut is illustrated herewith.

C



D



E

It combines an application of the double eccentric When it is desired to lock, the nut is run on to the bolt, and, when home, the outer section is moved to the right or left as is necessary. To unlock, the guide marks clearly shown in Figs. D and E, are brought into line again. We are informed that this locknut has a high efficiency; certainly it is a simple device at a cost which is apparently the same as the old-fashioned makeshifts.

ALCOHOL FUEL: A NEW COMMITTEE.

It is particularly gratifying to this journal to see the appointment, by Mr. Walter Long, the Home Secretary, of a Committee to investigate "the available sources of supply of alcohol, with particular reference to its manufacture from materials other than those which can be used for food purposes, the method and cost of such manufacture, and the manner in which alcohol should be used for power purposes." In an article on the subject of oil fuel or alcohol in its issue for August 8th last, *The Industrial Engineer* pointed out that this source of motor fuel offered unlimited possibilities, and was one that would relieve the existing demand on oil fuel supplies. It was pointed out, further, that it could be produced almost anywhere in the British Empire and so relieve us to a great extent of our dependence upon foreign sources of fuel supplies.

The Committee.

The *personnel* of the Committee is a particularly interesting one on its scientific side, and Manchester enquirers will be pleased, especially, that Dr. W. R. Ormandy finds a place on it. His various contributions to the investigations in connection with motor fuels have been very valuable, and in conjunction with the chairman of the Committee, Sir Boverton Redwood, Bart., some useful work should be done. Major Aston Cooper-Key, C.B., represents the Home Office; Mr. Arnold Philip, the Admiralty Chemist, the Navy side; Mr. H. F. Corlitt, the Industrial Power and Transport Department of the Board of Trade; Dr. J. H. Hinchcliff has been nominated by the Department of Agriculture for Ireland, a country in which, it is believed, a great deal of alcohol for power purposes could be cheaply produced and where, we believe, certain official investigations have already taken place; Professor Charles Crowther represents the English Board of Agriculture; Colonel Nathan, the Ministry of Munitions; Mr. H. W. Garrod, the Ministry of Reconstruction; and Sir Frank Heath, K.C.B., the Scientific and Industrial Research Department. The remaining members of the Committee are: Sir Frederick W. Black, K.C.B., Professor Harold B. Dixon, F.R.S., General Sir Capel Holden, K.C.B., F.R.S., Mr. E. S. Shrapnell-Smith, C.B.E., and Mr H. Wyatt.

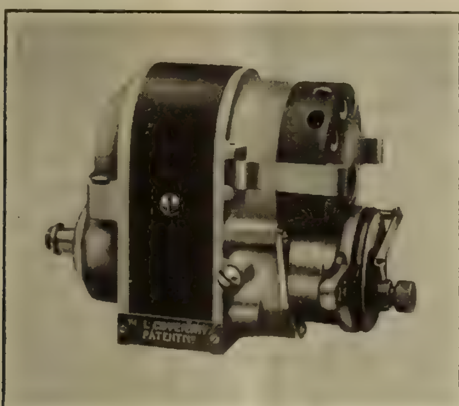
Alcohol from Edible Products.

It will be noticed that the investigations particularly rule out the obtaining of alcohol from edible products, such as potatoes, and there will be no doubt, some criticism of the terms of reference in respect of this feature. It is believed that the Irish potato crop, for example, could be greatly increased if a certain proportion of it were allocated for the purpose of producing spirit of the kind indicated, and some of those who ought to know say that it would pay the farmers to increase the land under potato cultivation in connecetion with this industry alone. Whether it would or not is a question that is not likely soon to be determined, for the reason that the Committee is not empowered to consider it. It is a pity, because it might have established the possibility of adding to the profitable character of another side of agriculture beyond any further contention. The Committee are, of course, well aware that there are abundant sources of alcohol supplies in Canada, India, South Africa, and Australia, and some steps should be taken to encourage alcohol production in those countries either by State subsidies or otherwise. We observe that the Colonial Office is not represented on the Committee, and this is surely a mistake because it is quite clear that it would be infinitely cheaper to manufacture alcohol from the prickly pear of Australia, for example, which is a plague to farmers there, than to waste time in connection with materials which are either limited in character or are too expensive to produce or collect. Whilst we do not wish to see anything ruled out of the investigations in these islands, we consider the Colonial field by far the most promising.

Economy of the Concrete Ship.—The economy of the concrete ship cannot be finally determined until designers have had time to work out the many improvements which have already been suggested by practical experience, but even on the present basis the first cost of reinforced concrete is not more than two-thirds that of steel, and the absence of costly maintenance charges will make the ultimate economy of concrete very much more.

THE M.L. MAGNETO.

It is difficult to understand nowadays how extremely obtuse we were in the years preceding the war in regard to the development of German industry to the exclusion of our own. Recently we have seen it stated that the best protection is afforded by technical education of a character that will lead to the increased institution and development of industries within our own borders, and surely this has been proved many times over since 1914. Government assistance enabled German magneto manufacturers to build up powerful selling organisations in this country, and, being backed by large resources, a British magneto industry of any size was impossible. At the outbreak of war an extremely critical situation was created. German magnetos were out of the question, and the United States of America—the only source of supply—was not in a position to meet the demand either in sufficient quantity or requisite quality. During the early days of the war there was certainly a shortage of magnetos, but the absolute necessity of development was fortunately recognised by several firms, amongst which was Messrs. Morris and Lister Ltd, electrical engineers, of Coventry.



The M.L. Magneto.

This firm possessed a good general experience in the winding of fine wire coils similar to those used in magneto work. The result of a considerable amount of concentrated effort was the M.L. Magneto, an example of which is illustrated on this page. So rapid was the development of the concern, that a separate company was formed under the name of "The M.L. Magneto Syndicate Ltd," with large commodious works in Coventry. In a brochure recently issued by the firm, a series of illustrations showing the various departments are published. Details of operations are given, and the extreme care exercised in manufacture and testing is emphasised.

It is extremely interesting to note that the firm are taking steps to firmly establish their magneto on the market, and to improve on the foreign product previously used in this country. To attain this object the company are devoting especial attention to experimental and research work, both in regard to electrical performance and manufacturing processes.

BALL BEARINGS FOR ELECTRIC MOTORS.

Compactness is required under conditions usually found in general industrial applications for both alternating-current and direct-current motors. To obtain this, motor manufacturers develop, or try to develop, the greatest possible horse power from given frame sizes. The reduced size per horse-power capacity gives greater output for acquired motor space.

Babbitt bearings are usually designed with an over-all length of two and one-half or three times the diameter of the shaft which they are called upon to support. Contrasted with this, the length of the ball bearing proper on the shaft usually is not over one-third of the shaft diameter. Through ball bearings the over-all length of motors can be reduced from 10 to 30 per cent. To be sure, on motors in which the shaft is subject only to torque, bearing friction is a small percentage of the motor loss. This condition obtains for the most part in direct-coupled units, such as pumps, motor-generator sets, etc. These bearings carry little, if anything above the weight of the rotor, and the pressure between the shaft and the bearing is slight and friction is at a minimum. Wherever such motors are running at high speeds, even slightly unbalanced forces will produce considerable bearing loads that tend to increase friction and wear. Where the shaft is subjected to bending strains, bearing friction becomes an important consideration. This is the case of belt or gear-driven motors. The bearings are subject to severe binding, pounding, or shock, especially at the drive end. Ball bearings in these instances show a very decided saving over plain bearings, especially if the self-aligning type, which compensates for shaft deflection or misalignment, is used. Power saving in ball bearings is entirely due to the fact that their friction is practically constant over a wide range of loads and because rolling is substituted for the rubbing action of plain bearings. As ball bearings consume no more energy at start than they do at speed, acceleration is rapid and the starting torque improved several hundred per cent. Belt slippage is eliminated and it becomes possible to use smaller belts and pulleys.

To illustrate how a ball-bearing motor will run more satisfactorily under conditions of neglect than a plain-bearing motor, observe how two motors operating side by side, one on ball bearings, the other on plain bearings, will act. The plain-bearing motor, as soon as the oil has become exhausted, will heat up and the bearings will run to destruction, with the likelihod of the armature being stripped when bearing wear is sufficient to let the rotor rub on the pole pieces. On the other hand, the ball-bearing motor, because of the lubricant being held in the sealed chambers, and its lubricating properties not being exhausted as quickly as in plain bearings, will run for an indefinite period without showing any signs of heating or bearing wear. A motor of this kind requires oiling only three or four times a year to ensure perfect bearing operation.

ECONOMIES IN THE GENERATION AND USE OF STEAM.

By Sidney F. Walker, R.N., M.I.E.E., M.I.M.E.

(*Continued from page 29.*)

The Higher Efficiency of Condensers.

A great deal has been written, during the last twenty years, and a very large number of experiments have been made, dealing with the higher efficiency of condensers; the possibility of obtaining higher vacua, without corresponding disadvantages. The increased circulating water mentioned above, which ruled before the advent of the steam turbine, was one very serious disadvantage; where the cooling water had to be paid for at town's rates, condensing was often prohibited altogether because of the cost of the water; and the idea of purchasing the additional quantity of water required for higher vacua was unthinkable. Waterworks engineers of nearly every town, and certainly of all large manufacturing towns, have had a very difficult problem to face; the populations of the towns have increased very rapidly, and the requirements, in the matter of water, by each family, and by industries using water, have also increased enormously. To the waterworks engineer, therefore, any steam engineer proposing to use large quantities of water for condensing has been anathema; and he has discouraged the idea by putting a very stiff price upon the water. The introduction of cooling towers, and rotary coolers, has modified the position; but it may be fairly taken as an axiom that if very large quantities of water are required to produce high vacua, that fact would put high vacua out of court. The cost of pumping goes up so very rapidly, with the larger quantities that were required in pre-turbine days. For steamships the cost of cooling water is, of course, nil; it is taken from the sea, but the cost of pumping in percentage of the total power generated by the main engines, is still a serious matter, if large quantities are required.

Points to be Attained.

The points to be attained in an efficient condenser, one that is a help to the boiler, and the engine, or turbine, by reducing the quantity of steam employed, and therefore the quantity of coal consumed in the boiler furnace are:—

1. The highest possible degree of vacuum, with cooling water at the highest temperature that may rule during the year, and with the smallest capital cost.

2. The highest hot-well, or feed-water temperature.

3. The lowest cost for pumping:—(*a*) The circulating water, (*b*) the condensate, (*c*) the air, and other uncondensable gases.

A little consideration will show that the whole question turns practically upon the separation of the air, carbonic acid, etc., from the condensate; the more thoroughly this can be accomplished the higher is the efficiency, and the lower the cost of obtaining a given vacuum.

The Question of Separate Pumps.

The usual controversy between engineers is still in progress, as to the advantage of employing separate pumps to exhaust the air from the condenser, and to carry off the condensate. Before the advent of the steam turbine, and for some time afterwards, it was maintained that the most economical plan was to lower the temperature of the condensate, so that it would absorb the largest possible percentage of the air, and other gases; the condensate and the free air and gases being pumped out together. The great and long-continued success of the Edwards air pump is due to the fact that it accomplished this object to a larger degree than any other apparatus that had been put upon the market up to that date. It must be remembered, however, that, as the writer understands the matter, the Edwards and similar pumps deliver the air that has come over with the steam from the boiler, back into the boiler; and also the carbonic acid gas, and any air, or other gases that may have leaked into the condenser; so that the troubles mentioned above, due to the presence of air and carbonic acid in the water and steam space of the boiler is not lessened. The leakage of air into the condenser, due to imperfect joints in the enclosing vessel, at ports, etc., has a most important effect upon the problem involved in obtaining higher efficiencies in the condenser. If any appreciable quantity of air leaks into the condenser, considerably more work is thrown upon the pumps; whether one or two are employed, and the cost of obtaining high vacua is thereby increased, as also is the difficulty of maintaining them.

The improvement that has taken place in all engineering works, during the last forty years, has left the condenser on one side. Forty years ago, skilled mechanics considered that they were doing very well indeed if they fitted to 1/16th inch, and consequently the machine tools of those days, being only a little better than hand-work—in some cases not quite as good—it was difficult to get two surfaces that were to be in contact with each other, in vessels enclosing air and other gases, so truly machined, and to keep the surfaces so closely in contact at all points that air did not leak in. To-day, as is well known, fitting to a few 10,000ths of an inch is quite common, and machine tools have no difficulty whatever in producing plane surfaces that will prevent the escape of any appreciable quantity of air, or other gases into the condenser.

With outside air and gases practically excluded, the problem resolves itself into separating the air, etc., from the condensate, and one necessity of the case is maintaining the temperature of the condensate as high as possible. As mentioned above, the higher temperature of the condensate, the less is its capacity for absorbing air and other gases; consequently, if the condensate can be led away to its own pump, or to a chamber in which its temperature is maintained at at least as high a figure as that of the steam from which it was formed, there is a much better chance of separating out the air, etc., than if the condensate is allowed to flow on over the colder tubes, before passing out of the condenser. In the usual form of surface condenser, it will be remembered, the steam enters at the top of the condenser chamber, the circulating water entering at the bottom, and flowing through two banks of tubes in opposite directions before passing out at the top; hence the tubes at the bottom of the chamber are much colder than those at the top, and if the condensate formed by contact with the upper tubes is

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 62 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft
0	..	5 2 4	11 0 8	0 16 2 12	1 2 0 16	1 7 2 20	1 13 0 24	1 18 3 0	2 4 1 4	2 9 3 8	0
1	0 2 6	6 0 10	11 2 14	0 17 0 18	1 2 2 22	1 8 0 26	1 13 3 2	1 19 1 6	2 4 3 10	2 10 1 14	1
2	1 0 12	6 2 16	12 0 20	0 17 2 24	1 3 1 0	1 8 3 4	1 14 1 8	1 19 3 12	2 5 1 16	2 10 3 20	2
3	1 2 18	7 0 22	12 2 26	0 18 1 2	1 3 3 6	1 9 1 10	1 14 3 14	2 0 1 18	2 5 3 22	2 11 1 26	3
4	2 0 24	7 3 0	13 1 4	0 18 3 8	1 4 1 12	1 9 3 16	1 15 1 20	2 0 3 24	2 6 2 0	2 12 0 4	4
5	2 3 2	8 1 6	13 3 10	0 19 1 14	1 4 3 18	1 10 1 22	1 15 3 26	2 1 2 2	2 7 0 6	2 12 2 10	5
6	3 1 18	8 3 12	14 1 16	0 19 3 20	1 5 1 24	1 11 0 0	1 16 2 4	2 2 0 8	2 7 2 12	2 13 0 16	6
7	3 3 14	9 1 18	14 3 22	1 0 1 26	1 6 0 2	1 11 2 6	1 17 0 10	2 2 2 14	2 8 0 18	2 13 2 22	7
8	4 1 20	9 3 24	15 2 0	1 1 0 4	1 6 2 8	1 12 0 12	1 17 2 16	2 3 0 20	2 8 2 24	2 14 1 0	8
9	4 3 26	10 2 2	16 0 6	1 1 2 10	1 7 0 14	1 12 2 18	1 18 0 22	2 3 2 26	2 9 1 2	2 14 3 6	9

Weight of Beam advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight	lbs.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight
	5·17	10·34	15·51	20·68	25·85	1 3·02	1 8·19	1 13·36	1 18·53	1 23·70	2 0·87	2 6	

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 62 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 15 1 12	5 10 2 24	8 6 0 8	11 1 1 20	13 16 3 4	16 12 0 16	19 7 2 0	22 2 3 12	24 18 0 24	0
10	0 5 2 4	3 0 3 16	5 16 1 0	8 11 2 12	11 6 3 24	14 2 1 8	16 17 2 20	19 13 0 4	22 8 1 16	25 3 3 0	10
20	0 11 0 8	3 6 1 20	6 1 3 4	8 17 0 16	11 12 2 0	14 7 3 12	17 3 0 24	19 18 2 8	22 13 3 20	25 9 1 4	20
30	0 16 2 12	3 11 3 24	6 7 1 8	9 2 2 20	11 18 0 4	14 13 1 16	17 8 3 0	20 4 0 12	22 19 1 24	25 14 3 8	30
40	1 2 0 16	3 17 2 0	6 12 3 12	9 8 0 24	12 3 2 8	14 18 3 20	17 14 1 4	20 9 2 16	23 5 0 0	26 0 1 12	40
50	1 7 2 20	4 3 0 4	6 18 1 16	9 13 3 0	12 9 0 12	15 4 1 24	17 19 3 8	20 15 0 20	23 10 2 4	26 5 3 16	50
60	1 13 0 24	4 8 2 8	7 3 3 20	9 19 1 14	12 14 2 16	15 10 0 0	18 5 1 12	21 0 2 24	23 16 0 8	26 11 1 20	60
70	1 18 3 0	4 14 0 12	7 9 1 24	10 4 3 8	13 0 0 20	15 15 2 4	18 10 3 16	21 6 1 0	24 1 2 12	26 16 3 24	70
80	2 4 1 4	4 19 2 16	7 15 0 0	10 10 1 12	13 5 2 24	16 1 0 8	18 16 1 20	21 11 3 4	24 7 0 16	27 2 2 0	80
90	2 9 3 8	5 5 0 20	8 0 2 4	10 15 3 16	13 11 1 0	16 6 2 12	19 1 3 24	21 17 1 8	24 12 2 20	27 8 0 4	90
Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight
	27 13 2 8	55 7 0 16	83 0 2 24	110 14 1 4	138 7 3 12	166 1 1 20	193 15 0 0	221 8 2 8	249 2 0 16	276 15 2 24	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 18 in. × 7 in. × 75 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	6 2 22	13 1 16	1 0 0 10	1 6 3 4	1 13 1 26	2 0 0 20	2 6 3 14	2 13 2 8	3 0 1 2	0
1	0 2 19	7 1 13	14 0 7	1 0 3 1	1 7 1 23	1 14 0 17	2 0 3 11	2 7 2 5	2 14 0 27	3 0 3 21	1
2	1 1 10	8 0 4	14 2 26	1 1 1 20	1 8 0 14	1 14 3 8	2 1 2 2	2 8 0 24	2 14 3 18	3 1 2 12	2
3	2 0 1	8 2 23	15 1 17	1 2 0 11	1 8 3 5	1 15 1 27	2 2 0 21	2 8 3 15	2 15 2 9	3 2 1 3	3
4	2 2 20	9 1 14	16 0 8	1 2 3 2	1 9 1 24	1 16 0 18	2 2 3 12	2 9 2 6	2 16 1 0	3 2 3 22	4
5	3 1 11	10 0 5	16 2 27	1 3 1 21	1 10 0 15	1 16 3 9	2 3 2 3	2 10 0 25	2 16 3 19	3 3 2 13	5
6	4 0 2	10 2 24	17 1 18	1 4 0 12	1 10 3 6	1 17 2 0	2 4 0 22	2 10 3 16	2 17 2 10	3 4 1 4	6
7	4 2 21	11 1 15	18 0 9	1 4 3 3	1 11 1 25	1 18 0 19	2 4 3 13	2 11 2 7	2 18 1 1	3 4 3 23	7
8	5 1 12	12 0 6	18 3 0	1 5 1 22	1 12 0 16	1 18 3 10	2 5 2 4	2 12 0 26	2 18 3 20	3 5 2 14	8
9	6 0 3	12 2 25	19 1 19	1 6 0 13	1 12 3 7	1 19 2 1	2 6 0 23	2 12 3 17	2 19 2 11	3 6 1 5	9

Weight of Beam advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight
	6·25	12·50	18·75	25·0	1 3·25	1 9·50	1 15·75	1 22·0	2 0·25	2 6·50	2 12·75	2 19·0	

Weights of Lengths of Rolled Steel Sections.

Beam 18 in. × 7 in. × 75 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 6 3 24	6 13 3 20	10 0 3 16	13 7 3 12	16 14 3 8	20 1 3 4	23 8 3 0	26 15 2 24	30 2 2 20	0
10	) 6 2 22	3 13 2 18	7 0 2 14	10 7 2 10	13 14 2 6	17 1 2 2	20 8 1 26	23 15 1 22	27 2 1 18	30 9 1 14	10
20	D 13 1 16	4 0 1 12	7 7 1 8	10 14 1 4	14 1 1 0	17 8 0 24	20 15 0 20	24 2 0 16	27 9 0 12	30 16 0 8	20
30	1 0 0 10	4 7 0 6	7 14 0 2	11 0 3 26	14 7 3 22	17 14 3 18	21 1 3 14	24 8 3 10	27 15 3 6	31 2 3 2	30
40	1 6 3 4	4 13 3 0	8 0 2 24	11 7 2 20	14 14 2 16	18 1 2 12	21 8 2 8	24 15 2 4	28 2 2 0	31 9 1 24	40
50	' 13 1 26	5 0 1 22	8 7 1 18	11 14 1 14	15 1 1 10	18 8 1 6	21 15 1 2	25 2 0 26	28 9 0 22	31 16 0 18	50
60	! 0 0 20	5 7 0 16	8 14 0 12	12 1 0 8	15 8 0 4	18 15 0 0	22 1 3 24	25 8 3 20	28 15 3 16	32 2 3 12	60
70	: 6 3 14	5 13 3 10	9 0 3 6	12 7 3 2	15 14 2 26	19 1 2 22	22 8 2 18	25 15 2 14	29 2 2 10	32 9 2 6	70
80	13 2 8	6 0 2 4	9 7 2 0	12 14 1 24	16 1 1 20	19 8 1 16	22 15 1 12	26 2 1 8	29 9 1 4	32 16 1 0	80
90	0 1 2	6 7 0 26	9 14 0 22	13 1 0 18	16 8 0 14	19 15 0 10	23 2 0 6	26 9 0 2	29 15 3 26	33 2 3 22	90
Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	Weight
	3 9 2 16	66 19 1 4	100 8 3 20	133 18 2 8	167 8 0 24	200 17 3 12	234 7 2 0	267 17 0 16	301 6 3 4	334 16 1 20	

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ELECTRICAL WELDING IN CONCRETE SHIPS.—Electrical welding has recently been introduced in British concrete shipyards with satisfactory results for connecting various members of the reinforcement as an alternative to the use of wire ties. The welds are very quickly made and hold the bars so firmly in their final positions that the blocks, wedges, and distance pieces otherwise necessary can be entirely eliminated. Oxy-acetylene welding is also under consideration for the same purpose.

THE CAPTURED GUN "BERTHA."—This gun was employed in firing lately on Amiens. The tube, 26 ft. 3 in. in length, is mounted on a chassis quite twice its own length. The 11 in. gun points its 26 ft. nose skywards from the centre, and the rear part is covered by an iron awning, under which is the conducting trolley for the shells, which are stored in a truck immediately behind. Coupled to this wagon are three more, the first containing cartridges, and the remaining two being reserved as living quarters for the gun team. A technical expert present said that the gun was only good for 200 rounds. Fourteen men, according to the *Times*, are necessary to control her fire, and fifty men in all for every purpose. The shell weighs 620 lbs.

COAL WASTAGE AND THE BY-PRODUCTS.—That waste in every department of civil and military life is a crime against the nation has recently been strongly brought home to us on all sides, and the current issue of "A Thousand-and-One Uses for Gas," the monthly illustrated publication of the British Commercial Gas Association, 47, Victoria Street, London, S.W.1, gives some telling facts and figures regarding the loss of valuable substances sustained when crude coal is consumed in factory furnace or domestic grate. This "special by-products number" will come as a revelation to the many who do not realise the quantity of essentials manufactured from raw material recovered at the gas works by the distillation of coal into gas. We commend to all who even in these days are not as careful with their coal as they might be a study of the striking diagram which illustrates our dependence on its scientific treatment for many of the prime needs of life.

MORE CONCRETE SEA-GOING BARGES LAUNCHED.—Two of the large fleet of 1,000-ton reinforced concrete barges being built in many yards for the Director-General of Merchant Shipbuilding, were launched at Barnstaple and Barrow-in-Furness just recently. Several others are in an advanced stage, and further launches will quickly follow. These barges have been built to the Admiralty design and specification, and will be classified by Lloyd's Registry. Their principal dimensions are: 187 ft. 6 in. long overall; 31 ft. 6 in. beam at deck level; and 20 ft. 9 in. deep from deck to keel. They include three roomy holds, quarters for captain and crew, and other necessary accommodation for steam boiler, pumps, coal and stores. The lines are similar to those adopted in ordinary shipbuilding, and the barges resemble steel vessels in outward appearance, the chief difference being the lighter hue of the concrete.

RECORD SHIPBUILDING AT BARNSTAPLE.—The barge launched at this ancient seaport was commenced little more than four months ago, and this is the first vessel turned out by the shipyard branch of the British Construction Company, one of several firms working on the Mouchel-Hennebique system. The establishment is equipped with slips for the building of several barges and steam-tugs at a time, and occupies the site of a yard where wood ships were built for many generations by the forefathers of Mr. Percy Westacott, the head of the present firm. As the vessel rested on the ways in readiness for the launch, a good opportunity was afforded for inspection of her graceful lines, and the excellent finish of the hull, the favourable impressions thus formed being confirmed by the behaviour of the vessel during and after the launch. Among those present were Admiral Sir Guise ppe Lorenzi, of the Italian Embassy; Colonel E. Ferretti, Naval Constructor to the Italian Admiralty; Mr. H. A. Flinn, representing the Controller-General of Merchant Shipbuilding; Major Pintney, of the Ministry of Shipping; Mr. E. Potts, of Lloyds' Registry; Mr. W. Noble Twelvetrees, president-elect of the Society of Engineers, and many other invited guests, while both banks of the river were crowded by the townspeople of Barnstaple, who had assembled to commemorate the revival of the port as a shipbuilding centre.

allowed to flow down over the lower tubes, its temperature is lowered, and its capacity for absorbing air and gases is increased. Where the air and condensate are pumped out together, this is an advantage, because the pump has the less to do, the larger proportion of air and other gases that is dissolved in the water. It will perhaps be as well to mention another phenomenon here; when water absorbs a gas, according to the modern theory of physical chemistry, the gas is dissolved in the water, just as a solid would be; it becomes liquid, and in the process of solution it gives up the latent heat by reason of which it has assumed, or maintains the gaseous condition. The result of this is, the temperature of the liquid in which the gas is dissolved, is raised, and with it the ability to absorb the gas is lowered; so that there is more or less of a see-saw, when an ordinary combined air pump is working; that is why special means are taken in the successful combined air pump to lower the temperature of the condensate.

There is also another more or less of a see-saw taking place between the steam, or the vapour that comes over with the steam, and the condensate. It will be remembered that the temperature at which vapour, or steam, is formed from any body of water, depends directly upon the pressure; in the boiler for instance, as the steam pressure rises, so does the temperature at which it is formed from the water with which it is in contact; similarly, in a surface condenser, if the pressure of the steam and vapour bearing upon the condensate varies, so will the temperature at which vapour is reformed from the condensate. This is another of the problems that has always to be faced in every condenser, and particularly in the surface condenser; a certain quantity of steam is converted into water, and unless a similar quantity immediately flows into the condenser, the pressure of the steam and vapour upon the condensate is lowered, and a certain amount of it is reformed into steam or vapour. It appears to the writer that this difficulty also is dealt with fairly well by drawing off the condensate as early as possible after it is formed; being at the temperature of the steam, its ability to absorb air and gases will be limited to that temperature, and the possibility of a portion of it being reconverted into steam and vapour will be minimised. As he understands the matter, that is what is aimed at, and is more or less actually accomplished by condensers such as the Contraflo, and others mentioned below. It will be seen, the writer believes, that by draining off the condensate to the hot well, or to a feed-water heater, immediately it is formed, two objects are accomplished, the temperature of the condensate is maintained as near that of the steam from which it was formed as is practicable, and the separation of the air and gases from the condensate is assisted; in addition, the possibility of a see-saw between water and vapour is minimised.

It is possible that the power required for removing the air and the condensate separately from the condenser, by separate pumps, may be greater than that required for a combined pump; but he believes that it has been clearly established that the net cost in coal, or in percentage of fuel, is less with separate air and water pumps, than with combined pumps, and in any case the net gain by condensing is higher with seperate pumps than with a combined pump.

(To be continued.)

A CAUSE OF FAILURE IN BOILER PLATES.

By WALTER ROSENHAIN, D.Sc., F.R.S., and D. HANSON, M.Sc.

(From the National Physical Laboratory.)

(Concluded from page 31.)

IMPACT tests have subsequently been carried out on the samples thus treated, with the results given in Table III.:—

TABLE III.—BOILER PLATE No. 2.

Treatment.	Energy to Fracture. Kilogrammetres.
As normalised at 950° C	11·06
Normalised at 950° C.; hammered cold and annealed at 650° C.	5·52
Normalised, 950° C.; hammered between 600° C. and 700° C., and annealed at 650° C....	7·18
Normalised at 950° C., annealed at 650° C., without mechanical treatment	10·44

It will be seen that the normalised material again gives a high value, and that this value is not appreciably diminished by a further annealing at 650 deg. Cen. On the other hand, cold hammering

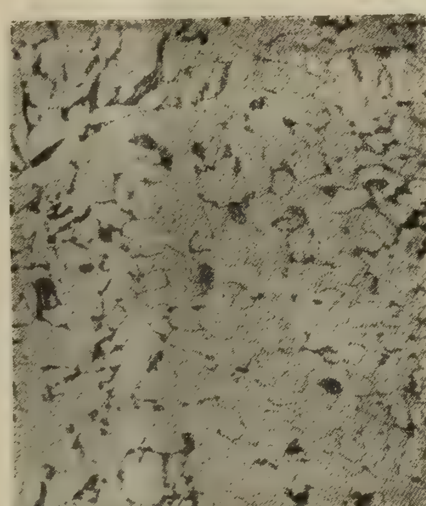


FIG. 12.

followed by annealing at 650 deg. Cen. lowers the impact figure to one-half of the normal value, while hammering between 600 deg. Cen. and 700 deg. Cen. reduces it considerably but to a lesser extent. The corresponding microstructures are illustrated in Figs. 12, 13, 14, and 15. Fig. 12 shows the material as normalised, Fig. 13 shows it after normalising and annealed at 650 deg. Cen. without mechanical treatment, Fig. 14 shows the effects of cold hammering followed by annealing at 650 deg. Cen., and Fig. 15 shows the effect of hammering between 600 deg. Cen. and 700 deg. Cen., followed by annealing at 650 deg. Cen.

It will be seen that, in general terms, the results obtained with this material are of the same kind as those found in the first plate, but, probably owing to the smaller scale of the banding originally existing in this steel, the results are not quite so intense in character. It may be mentioned that this plate also had failed in practice, but not during manufacture, and in a manner which is not necessarily related to the phenomenon of grain growth. The experiments on this plate, however, serve to confirm the observations made with the first example, but they indicate that in plates of a smaller thickness the effects are not likely to be so serious as in the larger plates.

FIG 13.

By way of a further check similar experiments hae been carried out on a further plate (plate No. 3), also half an inch thick, which is practically free from banding. The chemical analysis of this plate is as follows:—

FIG. 15.

	Per Cent.
Carbon	0·213
Silicon	0·059
Sulphur	0·032
Phosphorus	0·048
Manganese	0·700

The general microstructure of this plate is shown in Fig. 16 The absence of any marked banding will be noticed.

Impact tests have been made on specimens from this plate both in the condition as received and after thermal and mechanical treatment similar to that which has been applied in the other cases. The results are given in Table IV. :—

FIG. 14.

TABLE IV.—BOILER PLATE No. 3.

Treatment.	Impact Energy to Fracture.
As received	11·5
Reduced cold about 3 per cent; annealed, 650° C.	11·02 10·52
Reduced hot about 3 per cent; annealed, 650° C.	12·38 10·70
Annealed 650° C., without mechanical treatment...	11·24 11·68

FIG. 16.

It will be seen that in this plate cold hammering and hammering between 600 deg. Cen. and 700 deg. Cen. followed by annealing at 650 deg. Cen. does not affect the impact figure, and microscopic examination shows correspondingly that no grain growth has taken place.

The results obtained with plates Nos. 2 and 3 thus confirm the view that the low impact figures found in the first plate, and to a lesser extent in plate No. 2, are associated with the coarse crystal structure in the carbonless bands, and that these are the result of grain growth produced by slight deformation and subsequent low temperature annealing; also that normalising in every case completely removes this source of weakness.

The authors are indebted to the Director of the National Physical Laboratory, Sir Richard T. Glazebrook, C.B., F.R.S., for his interest in the work, and to several of their colleagues for assistance in carrying it out, notably to Mr. R. G. Batson, A.K.C., A.M.Inst.C.E., of the Engineering Department of the Laboratory, who has carried out the mechanical tests described in the paper. The authors are also indebted to the various authorities concerned for their permission to utilise the materials and some of the data referred to in this paper.

(Concluded.)

METALLIC PACKING.

[Messrs. Snowdon, Sons and Co. Ltd., Millwall, London, E.]

Metallic packings have been and are largely employed for a variety of purposes, but to be entirely successful considerable care must be exercised, both in design and quality of material. It would be an easy matter for us to detail some common faults of metallic packing, but chief amongst them are the scoring of rods, the addition of friction instead of reducing it, and the necessity for constant supervision and adjustment.

Fig. 1.

An illustrated folder gives some interesting details of Snowdon's Metallic Packing. The illustrations herewith give a very good idea of the construction of the packing and its position when in use.

Snowdon's packing consists of hollow white-metal rings—in halves—made in all sizes for rods from ¼-in. diameter upwards; also for rams and plungers of any size. The rings are filled with graphite lubricant and the ends sealed up so that it can only pass through the small holes drilled for that purpose in the working surface (Fig. 1). When the packing is used for steam, four or more metallic rings, according to depth of stuffing-box, are arranged in conjunction with a solid white metal top ring and a turn of soft packing for expansion. This arrangement is shown in Fig. 2.

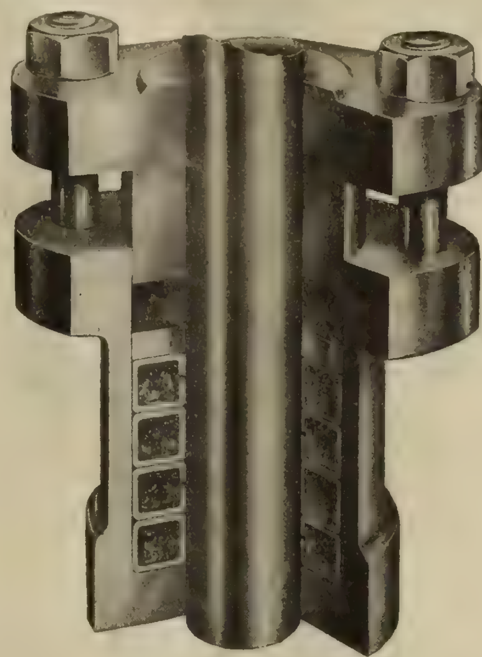


Fig. 2.—Steam.

The arrangement shown in Figs. 3 and 4 is for water, ammonia and CO_2. Four to eight metallic rings, with a thin Dureene washer between each, are employed. Above is a solid white metal top ring and four washers, which lie next to the gland.

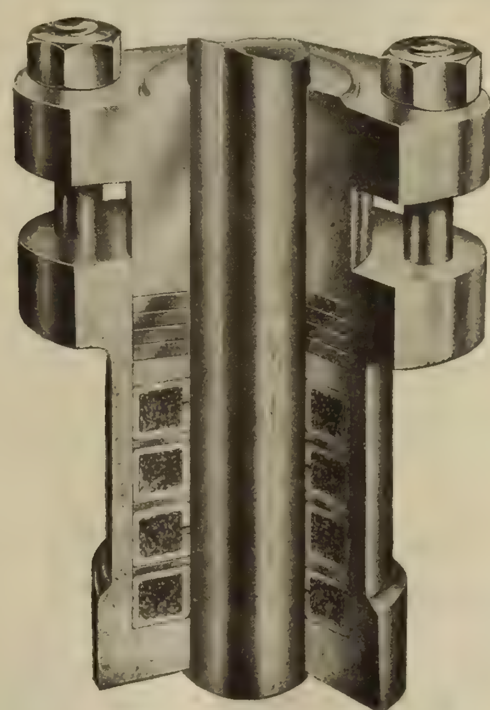


Fig. 3.—Water.

For higher superheat the metallic packing rings

are made of soft copper in place of the usual white metal. No stock is carried by the makers, who manufacture each set specially to order, exactly to dimensions furnished. The rings are a perfect fit between the rod and the wall of the stuffing box. It is claimed that

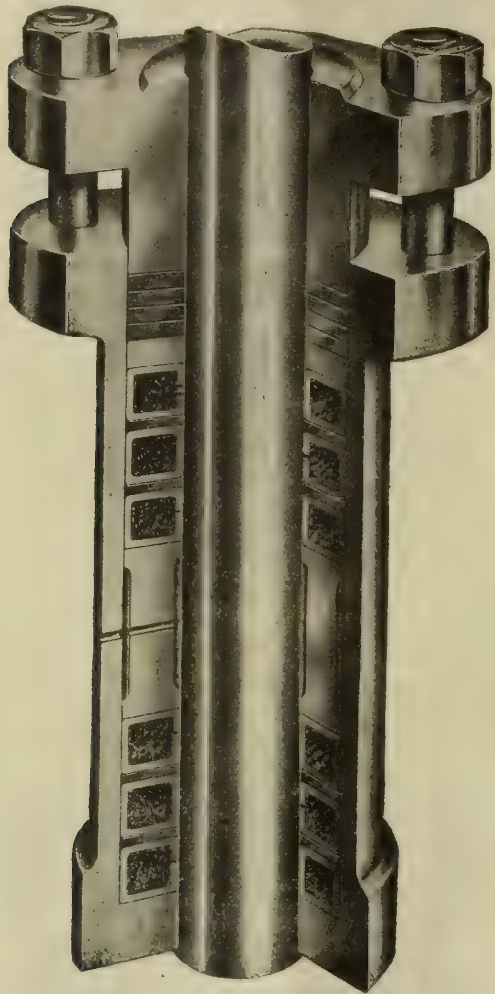


Fig. 4.—Ammonia and CO_2.

the rings, being made of soft metal, do not injure the rods, but after a few days' running impart a fine surface to the rod. The packing, it will be seen, has no springs, and it requires minimum attention. Pressure is absolutely immaterial, and the packing is suitable for nearly every purpose.

PIONEER ELECTRICAL ENGINEERING.

By F. Ashton.

Early Discoveries.

The philosophers who made the earliest discoveries in connection with electricity had no conception of what they would ultimately lead to. About 600 years B.C. a man named Thales, a Greek, found that amber, when subjected to friction, possessed the power of attracting feathers, straw, and other light materials, but it is somewhat doubtful if anyone, including Thales himself, considered this to be a matter of any particular importance. In 1600, A.D. —many years after Thales' discovery, let it be noted —Gilbert, an Englishman, began to study this phenomenon on a scientific basis, and he it was who first used the name "electrica," from which the word electricity is derived. Sixty-three years later, Guericke, a German, built an electrical machine, consisting of a globe of sulphur fixed on an axis, and rotated by means of a handle. This machine generated static electricity by friction produced by the operator holding his hand on the globe whilst it revolved. Discoveries of a most important character were made about 1750, by Benjamin Franklin, who demonstrated the identity of lightning discharges and the electric spark, invented the lightning rod, and added materially in other ways to the previously existing knowledge of electric phenomena. The next important worker in the electrical field was Volta, an Italian, who invented the electric pile in 1799. With his electric pile, Volta produced small currents, but it was Sir Humphrey Davy, an Englishman, who first produced a current of sufficient magnitude to give an electric arc light. With a voltaic battery composed of 2,000 plates, Davy succeeded in obtaining an arc between two carbonised wooded rods, a step in connection with electrical science of great importance. Oersted, a Dane, and Davy were the pioneer discoverers of the magnetic action of electric currents, although William Sturgeon, an Englishman, was the first to construct an electro-magnet. Henry, an American, also deserves praise for his useful work in connection with the development and practical application of electro-magnets, but it was left to Michael Faraday to lay down the principles of electro-magnetic induction, which led to the development of dynamo electric machinery. As all electrical engineers know, the work which Faraday did was of tremendous importance, and there is no doubt that he was one of the greatest physicists that ever lived, for the science of electricity as we have it to-day emanates very largely from his discoveries.

Dynamos.

The first dynamo, apart from experimental apparatus built by Faraday himself, was designed and built by Pixii, as early as September, 1832, and was very soon improved by Ritchie, Saxton, Clarke, and Siemens. Other pioneer workers in this particular field were Wild and Ladd, who built machines in 1864 and 1867 respectively. In 1870 Gramme invented his well-known ring armature, which was subsequently employed pretty extensively. But electric lighting was not established on a successful commercial basis until Brush, an American, introduced his series arc lighting system in about 1878. This development, together with the electric candles invented in 1876, by Paul Jablochkoff, a Russian officer, are generally recognised to constitute the foundation stones of the arc lighting industry. Jablochkoff is also credited with being among the first to suggest the use of transformers, but whilst he, together with De Meriteus, Mordey, Gordon, and others, took out patents for transformers, it was not until 1883 that Goulard and Gibbs introduced the first practical system making use of transformers.

Arc Lighting.

Arc lamps were used to a small extent in this country as far back as 1856, only, however, in

Dungeness and other lighthouses. On December 13th, 1878, the Victoria Embankment, London, was lighted for the first time with Jablochkoff candles, the current being supplied by a Gramme dynamo, now in the possession of the Institution of Electrical Engineers. From that time onwards, small electric supplies for lighting with arc lamps began to increase in number; although these were not public supplies in the true sense. A patent for an incandescent lamp had been taken out in 1841, but the first successful commercial lamp of this type was introduced by Thomas Alva Edison, in 1879, one year after the installation of the Jablochkoff candles on the Victoria Embankment. Many others did valuable work in connection with the development of incandescent lamps, especially Swan and Stearns, in England. To Sir George Lane Fox appears to belong the credit of having been the first to suggest that electricity should be sold to private consumers in the same way as gas; at any rate, he was the first to patent a public electric supply system. In a patent specification, dated October 9th, 1878, Sir George describes, in great detail, a general supply system, involving steam-driven generators, mains, branches and sub-branches, accumulators and meters; in fact, all the paraphernalia which a public supply entails. About the same time, Edison was also advocating public supplies in America, and in 1881 he erected a station in Pearl Street, New York. Before considering the first public supplies in this country, however, there are several early private plants worthy of mention. As far back as 1879 the late Lord Armstrong had utilised the energy of a waterfall at Cragside to produce electricity which was transmitted over a distance of 1,500 yards, by means of overhead wires, into his library, for the production of the arc light. In 1880 the arc light was substituted by an installation of 45 Swan incandescent lamps; similar lamps being also used in the year following for experimental lighting at Alnwick Castle. Later in the same year Lord Kelvin installed incandescent electric lighting in his house at Glasgow, the generating plant consisting of a gas engine dynamo and Faure accumulator—the first example, it is believed, of the use of accumulators in this connection.

The Paris Exhibition.

In the history of electrical engineering, the year 1881 is a very notable one, on account of the electrical exhibition held in Paris. The magnificent display of the most up-to date electrical machines and apparatus of the time filled many who visited the show with new inspirations, and there is no doubt that it did much to accelerate the electrical industry. Sir William Crooks, for example, returned from the exhibition full of enthusiasm, and immediately began to instal electric light in his house making his own lamps, and enclosing the wires in glass tubes. In 1882, the late Robert Hammond (the well-known consulting electrical engineer, who was responsible for much important work in this country) also installed electric light in his private residence, it being claimed that this was the first house in England to be fitted with electric light throughout, and to the exclusion of all other illuminants. The Paris Exhibition was notable not only on account of the good display of generators and other things associated with the supply of electricity, but also because of the remarkable collection of arc and incandescent lamps, which in those days were so essential to progress. One year after the Exhibition (1882), the first London public supply station was opened on Holborn Viaduct. This station was equipped with two Edison dynamos, each driven by a Porter engine, and each set having a capacity sufficient to light 1,000 16-candle power lamps. Later in the same year, Gordon alternators were installed in a station at St. Pancras for lighting the railway station and hotel, it being only a few years since these machines were removed. A second Edison plant was also put into operation, in 1882, at Appleton, Wis., U.S.A., this plant having a capacity sufficient for lighting 250 10-candle power incandescent lamps. A crude electric motor was built by Jacobi as far back as 1838, and in 1873 it was discovered that a Gramme dynamo would act as a motor, but all the early supply stations were built solely for lighting purposes, and it was not until about 1880 that engineers began to recognise that a new and important field remained to be explored in connection with the application of electric motive power to industry and transport

(To be continued.)

THE UNAFLOW STEAM ENGINE.

By D. H. Yates.

In presenting this series of articles, the author would like to explain that he has not endeavoured to go into practical or theoretical details of engine design involving intricate formulæ, as usually found in text-books. His object has been rather to point out and explain the main features, thermal and constructional, of the Unaflow steam engine, which tend to produce the high state of efficiency attained by this engine in comparison with steam engines of the ordinary or counterflow type.

Some Early Types.

Although the Unaflow steam engine is the latest type of steam engine now manufactured, yet the fundamental principles underlying this most modern and scientific engine were introduced and applied as far back as the year 1849 to a locomotive on the South-Eastern Railway, which ran for about three years, and was then discarded as a failure, probably due to some mechanical defect. (See the *Engineer*, April 25th, 1913, page 450.) Later, in the year 1885, Mr. J. L. Todd, an Englishman, took out a patent in Great Britain for a double-acting steam engine, with the steam ports at each end of the cylinder, and a common exhaust port in the centre of the cylinder controlled by the piston, and the main features of the engine which were emphasised were "hot inlet and cold exhaust," and it is this engine which is usually regarded as the first of its type, perhaps because of the fact that the inventor persevered for some time in trying to develop his ideas. Todd, however, seems to have carried out his investigations along wrong lines, as nothing of a really commercial value was developed by him. Other inventors appear to have worked on similar lines to Todd, and to have met with failure, and it fell to a German, Professor J. Stumpf, of Charlottenburg, to further investigate and develop the principles first laid down by Englishmen, as just described. Stumpf set out with the idea

of doing in one cylinder what is usually done in several cylinders, and it is the engine evolved from his investigations, which he named the Unaflow engine, with which it is proposed to deal. The subject matter of the article has been divided up into sections.

The author desires to acknowledge the assistance rendered by the firm with which he is engaged, in the production of diagrams, and the readiness with which the firm agreed to place plans, etc., at his disposal. He also wishes to thank the various friends who have been interested in this subject for their proffered assistance, which has been readily accepted when being of a suitable character. Perhaps at this stage it would be interesting to state that the author's firm was the first to introduce the Unaflow engine into this country, and that the first engine of this type made in this country was installed at Lakefield Mills, Farnworth, in the year 1910. The results obtainedwith this engine encouraged the firm to persevere in its manufacture,and later results with other engines of this type have justified this course. The firm has surmounted all the attendant pioneer difficulties, and the success obtained has been largely responsible for the adoption of the Unaflow engine by most of the leading engine-builders in this country, many of whom scoffed at the idea when first introduced.

Main Constructional Features.

The Unaflow steam engine is a double-acting reciprocating engine, and as its name implies, is one in which the flow of the steam through each end of the cylinder is in one direction, that is, it has a una-directional flow, or to use the abbreviated term, "Unaflow." The flow of the steam is similar to that of the steam turbine, where the steam goes in hot at one end and exhausts relatively cold at the other end, having its energy partially extracted as it

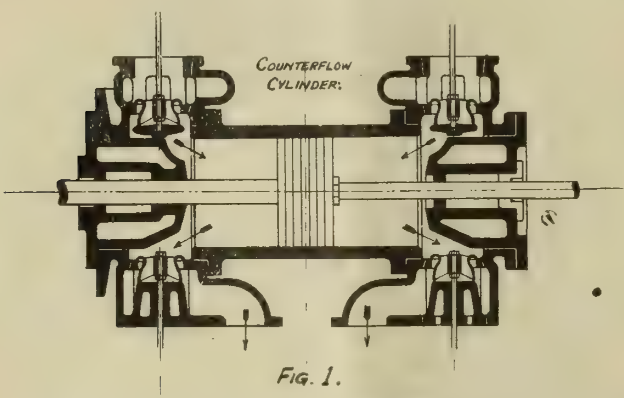


Fig. 1.

passes axially along the cylinder. This is effected by having a steam-admission valve at each end of the cylinder and a common exhaust port at the centre of the cylinder operated by the piston. In the ordinary steam engine the steam-admission valves and the exhaust valves are both placed at the ends of the cylinder, and the steam, after being admitted to the cylinder and having energy extracted during the stroke of the piston, has to pass back along its own path and finds its outlet at the same end of the cylinder as the inlet. In other words, it has a counterflow action. This is the main constructional difference between the ordinary steam engine cylinder and that of the Unaflow type, as is clearly illustrated by Figs. 1 and 2, and it is this constructional difference which creates the great thermal differences and their consequent effects between the two types of engine.

Cylinder Condensation.

The counterflow action of the ordinary steam engine causes considerable cylinder condensation, due to the following reasons: The cold exhaust steam in its passage back to the exhaust valve cools the

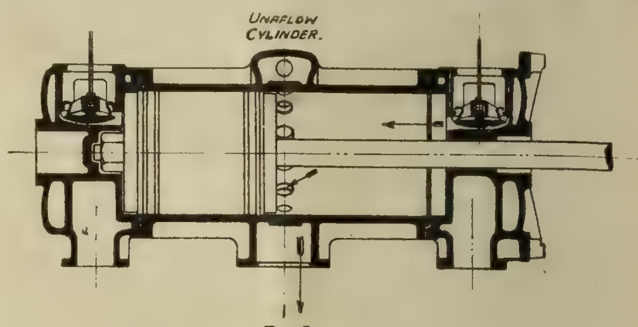


Fig. 2.

walls of the cylinder end, or, in other words, the clearance surfaces of the cylinder, so that they are considerably lower in temperature than the temperature of the admission steam. When fresh steam is admitted into the cylinder it comes in contact with the relatively cold walls of the cylinder, and some condensation takes place, and in the case where a high boiler pressure is used, and incidentally a higher temperature of steam, this condensation would be aggravated if a single cylinder of the ordinary type were used. Boiler pressures of 60 lbs. or 80 lbs. per square inch were at one time commonly used with single cylinder engines, but as higher pressures came into use engineers began to observe that the loss of power due to cylinder condensation was very considerable, and to obviate this they began to expand the steam in more than one cylinder, and so evolved the compound, triple, and quadruple expansion engines. By this means the range of temperature between the initial steam admission and the final exhaust is split up into several equal stages, so that there is less difference in temperature in each cylinder between the incoming steam and the exhaust steam, and so the latter, in its counterflow action, will cause less cylinder condensation than would be the case if a single counterflow cylinder were used. A further safeguard against cylinder condensation was the introduction of superheated steam, which allows for a certain reduction in the temperature of the admission steam without consequent condensation. The higher pressures involved in triple and quadruple expansion engines cause trouble with the lubrication of the high-pressure cylinder, owing to the average temperature in this cylinder being abnormally high, resulting in the carbonisation of the oil, and this, coupled with the extra cost of production and upkeep, has resulted in their being cast aside in favour of the compound engine, even though the steam consumption of the latter is slightly in excess of that of the triple or quadruple expansion engine. If now we go still one step further, and perform in one cylinder the work

usually done in two cylinders, we may reasonably expect a still more efficient and economical engine, provided that this engine is designed on correct lines, *i.e.*, by avoiding, as far as possible, any loss of power through cylinder condensation, which loss previously drove engineers to the adoption of the compound

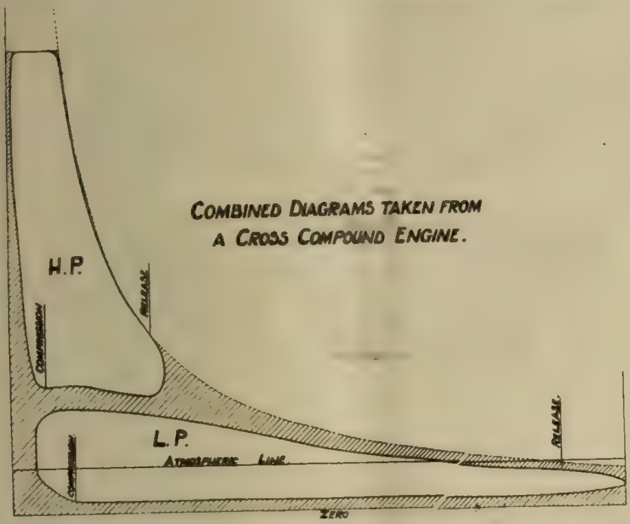


FIG. 3.

engine. This result has been achieved by the Unaflow engine, which, as previously explained, owing to its construction, reduces the cylinder condensation to a minimum, and has a similar effect to that obtained by using superheated steam in a counterflow cylinder, but in an intensified degree. Superheated steam may be used with the Unaflow engine equally as well and with more increased economy than is the case with the compound engine, and the

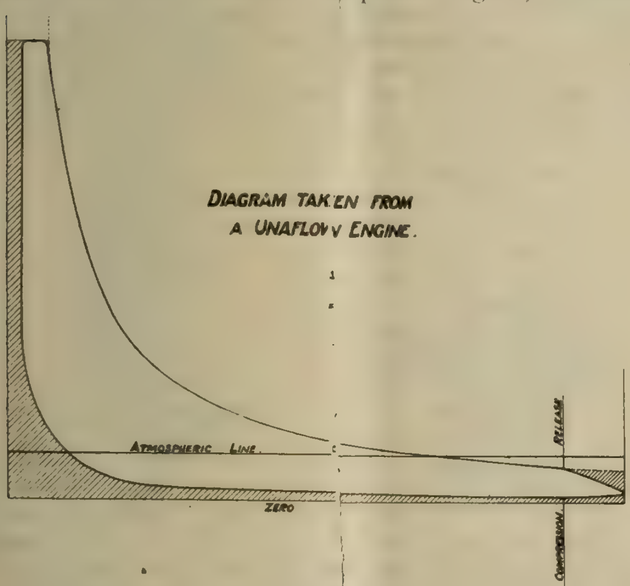


FIG. 4.

results of steam consumption compare favourably with those of the best compound and triple-expansion engines. In addition to the losses by cylinder condensation on clearance surfaces, it will be noticed, on examination of Fig. 3, which illustrates typical combined indicator diagrams taken from the cylinders of a compound engine, that the cylinder is connected for practically half of its cycle with the receiver in the case of the high-pressure cylnder and with the condenser in the case of the low-pressure cylinder; as a consequence, considerable heat is lost during the exhaust stroke of the piston, the effect of which is the cooling of the cylinder barrel and clearance surfaces, resulting in further condensation. If we now examine Fig. 4, which illustrates an indicator diagram taken from a Unaflow engine designed by the author, we find that the cylinder is connected with the condenser for only one-tenth of its cycle, as compared with one-half in Fig. 3. Owing to the variable piston speed, however, the actual period of time during which the condenser is in connection with the cylinder is in the ratio of about 1 to 2, and so more heat is retained in the cylinder of the Unaflow engine, with advantageous results. Another source of loss in multiple-expansion engines is found between the cylinders, where radiation of heat takes place from the steam and exhaust pipes and receivers, even when well covered. This loss is shown by any combined diagram made from indicator diagrams taken from multiple-expansion engines, and is clearly demonstrated in Fig. 3 by the hatched portion between the high-pressure and low-pressure diagrams, whilst in Fig. 4 the diagram is continuous from the point of steam admission right down to the final exhaust line, so eliminating intermediate losses. The intermediate losses in multiple-expansion engines can, of course, be reduced by the introduction of a reheater receiver, which regenerates the steam to a certain extent. This method is favoured by some engineers, and will not be tolerated by others, as the advantage thus gained is always of a doubtful character.

(To be continued.)

BRITISH INDUSTRIES FAIR, 1919.

For next year's British Industries Fair the Board of Trade have been able to secure from the Port of London Authority the great warehouses in Pennington Street which proved so highly satisfactory for the Fair held at the beginning of this year.

The Fair will open as usual on the last Monday in February (February 24th) and will remain open until Friday, March 7th.

In order in no way to interfere with the production of munitions, the Fair will again be restricted to the same trades which have participated in the last three Fairs, namely, glass and pottery, paper, printing and stationery, fancy goods, and toys.

As in past years, the invitations to visitors to the Fair will be issued by the Board of Trade, and admittance will be restricted to *bona fide* buyers interested in the above trades.

Over 2,000 forms of application for space have already been issued to manufacturers in the trades concerned, and it is expected that the number of firms anxious to participate will be considerably in advance of last year, when orders to the value of over a million and a half were placed. Eligible manufacturers who have not received application forms should, if they wish to participate, communicate at once with the Director, British Industries Fair, Board of Trade, 10, Basinghall Street, London, E.C.2.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.

Manchester Branch.—Altrincham Sub-Branch.

The first paper of the session was read before the members of the above branch on Wednesday, Oct. 23rd, 1918, in the Central Liberal Rooms, Altrincham, by Mr. D. Wilson, A.M.I.M.E., on "Steam Raising and Destructor Installations." The paper was very instructive and interesting. Mr. Wilson first gave a description and explanation of the working of different types of steam-raising and destructor installations, and also a full description of the details and construction. He must have spent much time and taken a great deal of trouble preparing his papers and the set of drawings and diagrams he had made. A few questions were asked by members, to which Mr. Wilson promptly replied. A very hearty vote of thanks was given to Mr. Wilson for his paper.

The following papers and discussions will be given in the Central Liberal Rooms (near Altrincham Station), commencing at 7-45 p.m. prompt, at which we will be pleased to see members from other districts :—Nov. 27th, 1918, "Apprentice Training," Mr. E. Gayter; Jan. 22nd, 1919, "Cams," Mr. Bennison, A.M.I.M.E.; Feb. 26th, 1919, "Sandblasting," Mr. R. G. Ankers; March 26th, 1919, "Gearing," Mr. R. Gayter. Admission by membership card.—W. G. Murphy, Altrincham Sub-Branch Technical Committee.

Letters to the Editor.

The Editor will always be pleased to hear from readers who desire to express their opinions upon engineering and kindred subjects. Letters should be as brief as possible and be written upon one side of the paper only. The insertion of a letter in our columns does not necessarily mean that we endorse the opinions expressed therein.

THE STEAM LOOP.

To the Editor of "The Industrial Engineer."

Dear Sir,—With reference to Mr. Parsons' article on the steam loop in your issue of October 8th (Fig. 2), I fail to see how he will be able to return the water from the bottom of steam separator into the boiler again, assuming that the separator is fixed in a position some distance below the boiler lever, as shown in his sketch.

Looking into the matter from a practical point of view, I think if Mr. Parsons will connect a drain cock (S) at the bottom of the vertical pipe A that leads from the separator to the condenser, he will find after the steam loop has been in operation a few hours on opening the cock (S) that it will discharge a fairly large amount of water, and not dry steam, as he assumes to be the case.

Further, I presume that he intends this loop to act as a kind of syphon after discharging all the air from the condenser.

I am afraid Mr. Parsons has overlooked one point in regard to the action of a syphon, namely, the length of the suction and discharge pipes. If the vertical pipes were the reverse to those shown in sketch, it would not be a difficult matter to create a certain amount of suction on the pipe A, as the pressure of water varies in proportion to the height in feet (.43 lbs. per foot).

Assuming his sketch is somewhat to scale, he has a vertical height of one and a-half times more on the pipe A than on his return pipe down to the boiler; therefore the steam separator becomes inoperative from the duties a separator is intended to do.

—Yours, etc. Jas. Warhurst.

Albert Terrace, Mossley, Oct. 23rd, 1918.

Machine Tools, Wood Working Machinery and Treadle Lathes.—With reference to the Machine Tools and Power Machinery Order, 1916, the Wood Working Machinery Order, 1917, and the Treadle Lathes Order, 1918, the Minister of Munitions hereby gives notice that as from the 16th September, 1918, all applications for a permit to purchase or enter into negotiations for the purchase of machine tools, power-driven wood-working machinery, or treadle lathes of 3 in. centres or over, suitable for use in cutting and working metal or suitable for use in cutting, working or operating on wood, under the above-mentioned Orders, must be made to The Controller, Machine Tool Department (T.M.7), Ministry of Munitions, Charing Cross Buildings, Embankment, London, W.C.2.

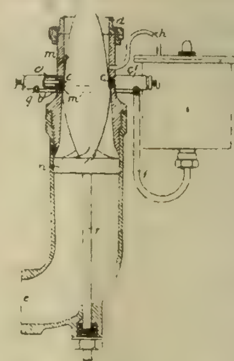
Patent Applications.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

ABSTRACTS OF SPECIFICATIONS.

INTERNAL-COMBUSTION ENGINES.

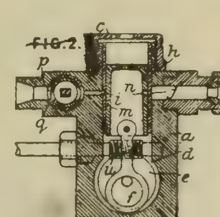
117,167.—A. A. Holle, Old Farm House, Great Woodcote, Purley, Surrey.—Feb. 11th, 1918.—A number of radial fuel nozzles *c* discharge into the air passage *d* of a spray carburettor which is controlled by a conoidal plug *m* with a control shoulder *m*1 acting in conjunction with a seating *b*1. The plug is actuated by a rod



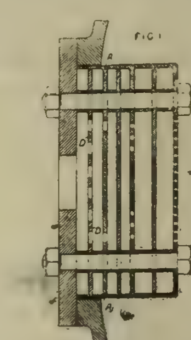
r and carries a piston *n* containing inclined passages to whirl the mixture on its way to the outlet *e*. The top of the float chamber is connected by a pipe *h* with the chamber *d* on the air inlet side of the nozzles. The nozzles are controlled by needle valves and their casings c1 are connected and supplied with fuel by an annular tube *g* and pipe *f*.

RECIPROCATING PUMPS.

117,201.—S. C. Dowler, 51, Warwick Road, Sparkhill, Birmingham.—Nov. 8th, 1917.—An oil pump for an internal-combustion engine comprises a barrel *a* closed at the end by a cap *c* and provided with diametrically-opposite inlet and outlet openings *i*, *j*, with which openings *m*, *n* in the hollow piston *h* are adapted to register during the suction and delivery strokes respectively. During the upstroke, a partial vacuum is formed inside the piston and gear chamber *d*, and oil enters through the ports *i*, *m*. After a number of strokes, the piston and chamber are nearly filled and enclose an air cushion at the top of the piston. During the downstroke, this air is compressed and forces the oil through the ports *n*, *j*. The inlet may be controlled by a throttling slide valve *q*, which is adapted to vary the size of the ports *p*, and may be actuated by the throttle of the engine. The piston *h* is actuated by worm gearing *a*, *e*, and an eccentric *f*.



Patent 117,201.



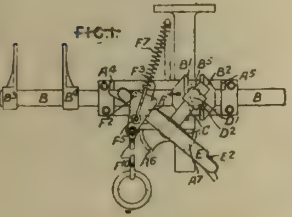
Patent 117,203.

STEAM GENERATORS.

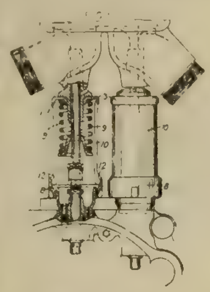
117,203.—A. Morgan, 35, Summerton Road, Govan, Glasgow.—Nov. 9th, 1917.—To prevent the emission of large quantities of steam through the safety-valve when the engine is suddenly stopped, the main steam pipe is placed in communication with the condenser through a branch pipe fitted with a control valve and having a baffle-device for expanding the escaping steam so that it can be dealt with by the condenser without the risk of injuriously high local pressure arising therein. The baffle-device is mounted at the end of the branch pipe inside the condenser and consists of a number of perforated dished plates A, and of flat perforated plates D secured inside the dished plates, the perforations diminishing in area and increasing in number in successive plates.

BELT-SHIFTING GEAR.

117,218.—G. PROKOFIEW, 37, Falside Road, Paisley, Renfrewshire. Dec. 27th, 1917.—A belt fork is operated in both directions by a single cord connected to a carriage F sliding along a bar E fixed to a T-shaped lever C, the short arm of which carries a pin D1 and block B5 moving in a groove between two projections B1, B2 on a bar B carrying the belt fork B3, B4. To vary the throw of the fork, the pin D1 can be adjusted along the lever C and is fixed by a screw D2. The carriage F consists of two plates connected together by rivets F2, F3 which engage in recesses E2 at the ends of the bar E to return the carriage in its extreme positions. When the cord is pulled, the lever is rocked about its pivot until its end encounters a stop A4 or A5, and the carriage F is then pulled to the opposite end of the bar E by a spring F7. Curved stops A6, A7 engaging a projecting pin F prevent the carriage from sliding prematurely. In a modification, the device is inverted and is operated by a pedal, the cord F10 passing over a guide-pulley.



Patent 117,218.



Patent 117,235.

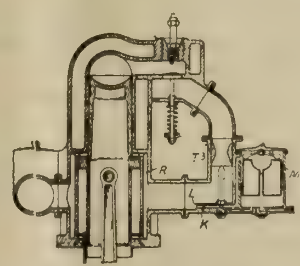
INTERNAL-COMBUSTION ENGINES.

117,235.—F. A. KIMBERLEY and JAMES CYCLE CO., Greet, juxta Birmingham.—Feb. 25th, 1918.—Valve springs 9, etc., are protected from dust by enclosing them in casings 10 having bevelled ends 11, 12 which engage a collar 3 and a nut 8. The casing may be split longitudinally and hinged, or it may comprise two or more separte parts. One end only of a casing 10 may be bevelled.

STEAM GENERATORS.

117,239.—A. H. ANTHONY, Capel House, Colchester.—Feb. 27th, 1918.—A boiler-feed apparatus of the type in which the check-feed valve is actuated by the water acting on a leaky piston under the control of a float-actuated auxiliary valve, has a balanced auxiliary valve. In the form shown, the auxiliary valve is formed as a double-beat valve having one face F1 adjustable by means of a screw-thread F3 and lock-nut F4. The upper seat is held in position by a cage member D having ports D1 leading to the space below the lower beat and ports D2 leading to the space above the upper beat. The valve is opened by the float acting through a sliding piece G1 and tappet G either bearing against the valve member or screwed thereto. In a modification, a simple lift valve member prevented from rotating by a transverse pin is balanced by means of a piston.

Patent 117,239.



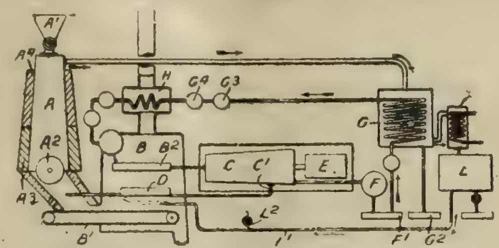
Patent 117,249.

INTERNAL-COMBUSTION ENGINES.

117,249.—USINES G. DERIHON SOC. ANON. and E. DERIHON, 3, Piccadilly, London.—Nov. 19th, 1917.—A carburettor supplied with compressed air from a reservoir R has a closed float chamber M communicating with the conduit T3, between the reservoir R and the inlet valve, by means of a passage K, the end L of which is at right-angles to the conduit T3 and in the direct air current, so that the fuel in the reservoir is under a pressure due to the motion as well as to the compression of the air. Specification 116,644 is referrd to.

POWER-GENERATING SYSTEMS.

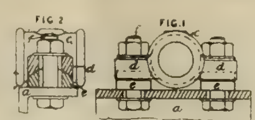
117,290.—MERZ & MCLELLAN, 32, Victoria Street, Westminster, A. C. MICHIE, 77, Rosebery Crescent, Jesmond, Newcastle-on-Tyne, and E. G. WEEKS, 1, Tynedale Avenue, Monkseaton, Northumberland.—July 6th, 1917.—A power-generating system comprises a gas retort in which the coal is coked by high-pressure steam to produce gaseous products which are condensed to form oils, etc., as by-products and a gas which is used for heating a boiler system which is supplied with its main heat by the combustion of the coke which is automatically fed from the retort, the boiler being used to drive a turbine which drives a dynamo or other power element. The boiler system comprises a low-pressure superheater which supplies the steam to the retort and is fed by steam tapped from the turbine, and a high-pressure superheater which feeds the turbine and the water for which is fed through a condensing coil which cools the gaseous vapours, this feed-water being provided with auxiliary heaters and being passed through an economiser arranged above the boilers. As shown, a retort A is automatically fed with coal by a device A1, and the coke is discharged by a device A2. The retort is lagged with a kieselguhr covering covering A3 and a magnesia covering A4. A mechanical feed B1 carries the coke to the furnace of a boiler B which comprises a high-pressure boiler B2 which supplies a turbine C for driving



a dynamo E. Steam is tapped from the turbine at C1 and supplied to a low-pressure superheater D which directs a blast of steam to the retort A and effects coking of the coal. The turbine discharges into a condenser F, and hot water is pumped from the hot-well F1 by pumps G3 and passes through a condenser G whereby the water is further heated and the gaseous products cooled, the condensed oils, etc., being drawn off at G2. The water passes through heaters G4, and an economiser H before reaching the boiler B2. After passing condenser G, the gas is further cooled by a cooler K, and it then passes to a stripping plant L and the uncondensed gas is passed by a pipe L1 to heat the boiler D, or by a pipe L2 to an internal-combustion engine. The coke from the retort A may be discharged in part to a gas-producer which supplies gas for heating the boiler O or for driving an internal-combustion engine.

BEARINGS.

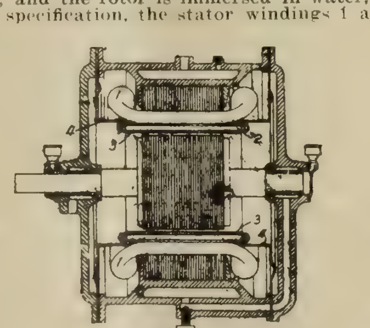
117,241.—A. C. NICHOLSON, Trent Iron Works, Newark. March 6th, 1918.—An adjustable self-aligning bearing for light spindles used in agricultural machinery, etc., comprises a bearing-block *c* formed with side wings *d* fitting on to curved loose blocks *e* resting on a flat plate *a*. Bolts *f* pass through slots in the parts



a, *e*, *d*, allowing limted adjustment and swivelling in horizontal and vertical planes. The block *c* may contain ball bearings. The wings *d* may be curved on both sides, curved washers being placed between the upper sides and the nuts. The bolt heads may rest against curved seats on the underside of the plate *a*. The two blocks *e* may be in one piece.

ELECTRIC MOTORS.

117,296.—T. L. R. COOPER, 10, Gordon Road, Ealing, London.—July 10th, 1917.—In submersible electric motors of the squirrel-cage induction type and wherein the stator is immersd in oil or other insulating-fluid, and the rotor is immersed in water, as described in the parent specification, the stator windings 1 are carried in

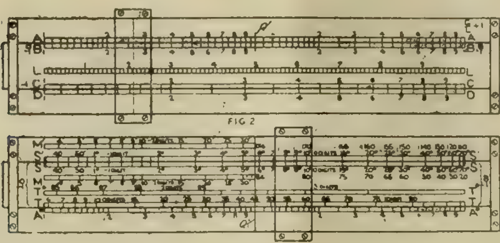


closed slots and the interior surface of the laminated stator forms a part of the watertight enclosure for the windings. The end covers 4 of this enclosure are provided with end rings 3 secured to the stator laminations by bolts 2 which lie in some of the stator slots.

SLIDE-RULES.

117,318.—A. C. CHEW, 1, Sarsfield Road, Balham, London. July 26th, 1917.—A slide-rule for use in solving problems in plane and spherical trigonometry in addition to the ordinary uses of a slide-rule comprises on one side log-scales A, B, to a double

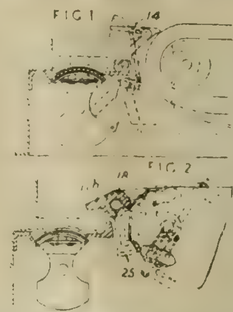
radius, preferably of 25 cm. and log-scales D, C of single radius, the scales A, D being on the stock and the scales B, C on the slide. In addition, there is formed on the slide a scale L of logs used in connection with the scale D. On the reverse side are log-scales M, M' of minutes reading from 4 to 34 minutes, which scales may be read as sines or tangents and the circular measure of these angles may be read on a scale A* which is similar to the scales A, B. The graduations of the 10, 20, and 30 minutes are differently coloured to indicate that from them can be obtained the values of 1, 2, and 3 minutes. Scales S, S' are log-scales of natural sines from 34 minutes to 90 degres set out to a single radius, the supplements of the angles being marked above the graduations on the scale S' and the complements above those on the scale S. The scales M', S', A* are carried by the stock and the scales S, M by the slide on which are also formed to a single radius two log-scales T, T* of tangents,



graduated respectively from 5 degrees 43 minutes to 84 degrees 17 minutes and from 84 degrees 18 minutes to 89 degrees 59 minutes. From the scales M, M', S, S' in co-operation with the scales A, A*, B can be obtained the circular measure, sines, cosines, secants, cosecants, and tangents of angles from 1 minute to 5 degrees 42 minutes, from the scales T, T* tangents of angles from 5 degrees 43 minutes to 89 degrees 59 minutes. The scales M, M', T* may be differently coloured to the remainder, and the centre indices of the scales A, A*, B and the centres of the scales S, S', T, T* are distinguished by longer differently coloured lines Q, Q'. Various formulæ such as $\frac{G}{L} \times 1$, O—1, B—1 are placed at different points of the scales, the first being employed in the operation of division and the others used in conjunction with the lines Q, Q1 to obtain the decimal point in multiplcation, examples if their use being given in the Specification.

FURNACES.

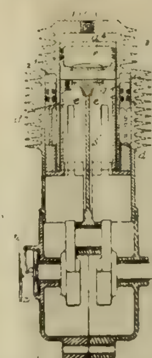
117,593.—BABCOCK & WILCOX, 30, Farringdon Street, A. E. PARKER, 56, Lyncroft Gardens, West Hampstead, and C. S. DAVY, 162, Rosendale Road, Dulwich, all in London, and D. G. MEIKLEREID, 98, Burnt Ash Hill, Lee, Kent.—June 19th, 1917.—An ash-clearing plate for a chain grate comprises a forwardly-projecting portion adapted to contact with the rear end of the grate, and a rearwardly-projecting portion or portions hinged thereto and adapted to be raised and lowered independently. As shown in Fig. 1, the rearwardly-extending portions or flaps 14 are operated



by levers and links. As shown in Fig. 2, the flap portions 11b are mounted on a shaft 18, which may be turned by a worm and quadrant 25 so as to raise and lower them.

INTERNAL-COMBUSTION ENGINES.

117,642.—L. S. HINKS, Limpsfield, Widney Road, Knowle, Warwickshire.—April 28th, 1917.—An engine in which an impulse occurs every revolution has an annular explosion chamber a5 arranged



concentrically with a second explosion space a4, the two pistons g and e being connected together and reciprocating in chambers formed by a cylindrical liner d. Separte inlet and exhaust valves are provided for each combustion space, and the piston e is cut away at s to facilitate lubrication.

INDEX TO ADVERTISERS.

[*When enquiring of Advertisers will readers kindly make a "special point" of mentioning* THE INDUSTRIAL ENGINEER.]

THE

Industrial Engineer.

Vol. VII.] NOVEMBER 22nd, 1918. [No. 171.

The Industrial Engineer.

A PRACTICAL MAGAZINE FOR ENGINEERS AND POWER USERS.

Published twice monthly, on the 8th and 22nd days, respectively.

All communications intended for insertion in the Industrial Engineer, *or relating to Editorial matters, should be sent addressed to "The Editor," at our Office, 121, DEANSGATE, MANCHESTER, and must be accompanied by the name and address of the writer. Anonymous letters will not be noticed. We cannot undertake to return manuscripts or drawings, and correspondents are warned to keep copies.*

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CONTENTS.

EDITORIAL.

TECHNICAL CODIFICATION.

Every man who for the sake of pure knowledge or for more ulterior motives endeavours to keep himself abreast of current technical knowledge finds that no method exists whereby he is kept posted. In fact, nothing but a knowledge of the technical Press, extensive and peculiar as Sam Weller's, will enable him even to know in what quarter to look for required information.

This matter concerns those who desire to compass the ramifications of a single subject as well as those with broader interests to serve. Information vital to the experimenter, the inventor, and the manufacturer alike, may exist to solve difficulty and resolve doubt, or to avoid needless expenditure, but unless it is available by reasonable search, there are few who know even where to turn for light and guidance. There exists an immense amount of material—literally scores of tons of it—embalmed and buried in treatise journal, society transactions, monograph catalogue, and text book, and up to the present no one has made it a business to catalogue for general information this vast mine of knowledge. There are one or two journals who give periodically some references to the mass of material during the preceding period, but classification, digest, and index in a complete sense there is none.

Such a compilation is very badly needed. The mass of material extends and multiplies, and no one yet has overcome the initial difficulty of attacking the mountain with a shovel to grade its contents, and allow speedy reference to those who need it most, *i.e.*, those whose time is least.

So far as the automobile industry is concerned, a start at all events has been made. Mr. Savage, the Coventry City Librarian, in a paper before the Institute of Automobile Engineers, opened up the subject in a very able manner. He has attempted the pioneer task, but has come to the conclusion that its furtherance should be entrusted to the Institution most concerned.

Each of the technical institutions has a library wherein books and journals of value to their members are placed. In addition, there is the British Museum and the Patent Office, where search can be made, yet a vast amount of valuable time can be spent tracking down available information, even if every source is open to the investigator.

In addition to British sources, there are American and Continental, and the ramifications of first-hand technical information are enormous.

There is strong evidence for a really competent authority, supported by all the quarters indicated taking over this very important matter. It should be statutory for every manufacturer to file a copy of every catalogue with such a body. A copy of every technical treatise—English or foreign—should be upon its shelves, together with every journal extant. What is more, no pains or expense should be spared to prepare catalogues, indices, digests that instantaneous reference can be made at request without loss of time. Many large manufacturers procure through an agent patent specifications affecting their product as and when they appear, in addition in some desultory manner journals and books bearing on their work are filed. Yet even so, reference is tedious and protracted; for classification in a real sense involves expense and special staff, impossible in the normal work, where every individual must justify his labours.

Premising that an information bureau would not be a commercial venture and a technical Review of Reviews appeal only to a limited *clientèle*, and so not pay expenses, there is a clear case for State aid. The first essential of scientific research is observation; the second, classification; the third, record of data. The two last in technical literature require an investigator who might conceivably achieve eminence by his labours. The trained librarian whose merits are profound lacks technicality sufficient, the expert engineer lacks the necessary training for codification; yet it is only the technician who can discriminate and sort out the material. There is a vast amount of talk about the reconstruction of industry; there is also a new department of Scientific and Industrial Research, but this question of codification of existing knowledge is of direct practical utility to student, investigator, inventor, manufacturer, merchant, and technician alike; and since existing knowledge is the prime basis of future endeavour, the more accessible and widely circulated is ascertained fact and practice; the more definite the progress towards the goal—improvements.

A vast territory exists for exploration, an enomous mass of material requires digestion and means of easy reference: and a centralised authority to whom the task is delegated would repay a thousand-fold the small expenditure needed from the public purse. If such activity cost £100,000 per annum, it would save at least ten times the sum directly, while its indirect benefit would be incalculable.

It must not be forgotten that stimulation of industry is a distinct function of the modern State, and that dissemination of knowledge is the one aspect of State aid to industry to which no exception can be taken by any concerned. The task outlined is obviously beyond the power of any single individual, however able; but the methods whereby the Oxford Dictionary were compiled, assisted by numberless contributors outside the main compilers, but by their invitation, and under their direction, might be employed. Such methods would add each individual's file to the common stock, and so make possible an *Encyclopædia Britannica* of technical information. The influence of such a bureau and its publications upon industry would add to national prestige, in addition to its other easily realised benefits.

Such a technical State Department for the compilation and digest of technical knowledge would form in time a clearing house of ideas. It would link up University, private research, institution patent office, individual library, student, professor, manufacturer, publisher, into one common focal point, it would knit up disjointed effort into a coordinated whole, giving to each enquirer *all* the available information in print upon a given subject in a brief space of time.

The prospect seems alluring, the benefits great, the need imperative.

Trade Items, Notes, &c.

Mr. W. Holehouse, managing director of the Davenport Engineering Co. Ltd., and patentee of the Bradford patent cooling towers, has severed his connection with the company, and is commencing business at 21, Morley Street, Bradford, on his own account, for the purpose of designing and manufacturing special cooling plant for large turbines.

Mr. C. M. Dorman, of the Ordsall Electrical Works, has been appointed one of the advisory members of the Royal Technical Institute Sub Committee by the Salford Corporation.

The British Vice Consul reports considerable progress in shipbuilding and engineering works at Cadiz. The "Astilleros Gaditanos" is erecting its own electric generating station.

Mr. Freeman B. T. Trevelyan (Messrs. Sir W. G. Armstrong, Whitworth and Co. Ltd., Openshaw) has joined the Board of the Manchester Steam Users Association.

The provincial Danish shipyards continue to extend their scope and enlarge their plant; for this purpose fresh capital is needed, and three yards are simultaneously increasing their capital, the Marstal Steel Shipbuilding Company, with 500,000 kroner, the Vulkan yard at Korsör also with 500,000 kroner, and the Vindö yard, Hobro, with 700,000 kroner.

Norwegian owners have ordered seven good-sized motor vessels in Holland, having an aggregate tonnage of 38,450 tons, in addition to which five vessels, of an aggregate tonnage of about 6,600 tons are in course of construction, and one of 2,850 tons and one of 3,000 tons, the latter of which is being fitted with a new type of motor developing 2,000 H.P.

Messrs. Sterns Ltd., of Royal London House, Finsbury Square, London, inform us that their "Glandoline" substitute for tallow having met with so much success as a friction reducer on lathe and grinding machine centres, they have, in response to many requests for a lower-priced article, turned out a new Sternol lathe paste, of which they will be pleased to send a sample to any reader upon application.

The Minister of Munitions announces that in future second-hand machine tools, second-hand woodworking machinery and second-hand treadle lathes may be bought and sold without the sanction of the Ministry and without restriction as regards price. This suspension of regulations, however, does not in any way affect the position with regard to new tools, to which the regulations still apply in their entirety. A further notification concerning new tools will be issued in the course of the next few days.

The directors of Hudson's Consolidated, in an interim report to the shareholders, state that the company has acquired an important group of properties producing one of the elements indispensable to the manufacture of high-class steel, for which there is, and must continue to be, a great demand. These properties are being equipped with modern electrical plant on a commensurate scale, and the arrangements made place the company in an advantageous position in the iron and steel industry of Great Britain.

The yield of an oil-well may be diminished, and in some cases stopped, by the cooling of the rock-beds due to ingress of air. The crude oil is thereby thickened, and its flow through the crevices and porous channels in the beds is checked or wholly arrested. The remedies commonly used are hot water, steam, or hot air. These, however, are effective for only moderate depths. The oil is heated without loss, and, much gas being generated, a pressure is set up which in some cases has forced the oil to surface in bore-holes of great depth. The system is as effective in wells a thousand metres deep as in those of little depth. The military commands have used the system of electrical heating to restore to working order temporarily abandoned mines in Galicia and Roumania.

Sir W. G. Armstrong, Whitworth and Co. Ltd., of Openshaw, Manchester, have now appointed the following district representatives throughout the country, and have opened permanent district offices in connection with their tool steel and small tools business:—London and Southern District: Representative, Mr. Ernest Wilson, 8, Great George Street, Westminster, S.W.1; telegrams, "Zigzag, Parl, London"; telephone, 4010 Central. Scotland and Ireland: Representative, Mr. A. S. Jones, 137A, St. Vincent Street, Glasgow; telegrams, "Tulesteel," Glasgow; telephone, 2214 Central. Midland District: Representative, Mr. Walter Todd, 158/161, Great Charles Street, Birmingham; telegrams, "Waltod, Birmingham"; telephone, 417 Central. North-Eastern District: Representative, Mr. J. D. Smith, Pilgrim House, Pilgrim Street, Newcastle-on-Tyne; telegrams, "Crucible, Newcastle-on-Tyne"; telephone, 241 Central. Lancashire and Wales: Representative, Mr. T. W. Etchells, 5, John Dalton Street, Manchester; telegrams, "Hispeed"; telephone, 899 Central.

DRAWING OFFICE SYSTEMS AND MANAGEMENT.

By M. CORONEL.

FOR the efficient running of a Drawing Office, as with most other things it is necessary to employ modern, improved methods, and the management costs can be considerably brought down by converting a Drawing Office run on old-fashioned lines and almost without system into one run on an improved, modern system.

In the following articles we shall endeavour to lay down one or several modern Drawing Office systems. A system to be efficient should be simple and comprehensive in use. The Drawing Office should theoretically resolve itself into (1) a designing office; (2) a tracing room; and (3) a material order office, both for material to be ordered from outside and for all the material to be used in the shops, and taken from their stock. It should be pointed out here that except for very large works the Drawing Office should do the whole of the correspondence and the ordering of special parts, instruments and other details ordered outside, apart from the ordering up of store stock, as of bolts and nuts, bars of various material, sheets of various material, etc., which material should be ordered by the store-keeper or purchasing clerk. It has been found that if the ordering of special parts, etc., is left to the latter, his lack of technical knowledge as to the special requirements and of engineering training often leads to endless trouble. The chief-draughtsman or departmental section leader should be made responsible for all such ordering, and the getting in of quotations for these parts should be included in the Drawing Office routine.

A Book for Calculations.

Every draughtsman should be given a substantial book in which to enter all his calculations, this book to be kept for future reference, and essential calculations should be

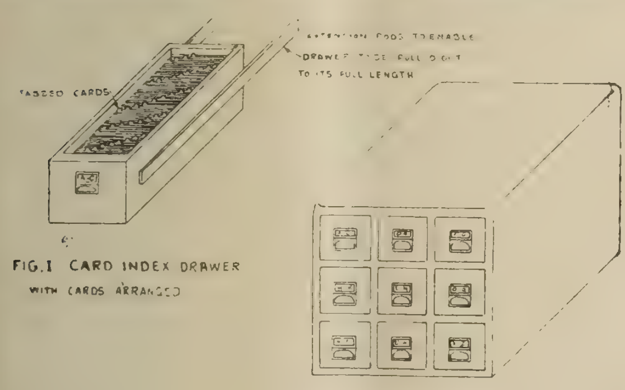


FIG. 1 CARD INDEX DRAWER WITH CARDS ARRANGED

FIG 2 CARD INDEX CABINET FOR NINE DRAWERS

entered therein by him. Engineering calculations should be made, as a rule, by means of the slide rule, being accurate enough for most cases, saving considerable time and minimising, after some practice, the liability to make mistakes.

Standards.

Every well-organised Drawing Office should have its well-thought-out standards of articles and parts frequently used, and these should be drawn out or listed out on small sheets and be collected in a loose-leaf book form. Two or three of these books should be in the Drawing Office, according to the size of same, one for general use, one for the Chief, and one for the checker, if one is employed. The various shops and the designers should also be supplied with a copy of these books, and in a large works having several departments, the various departments should let each other have a copy of the other's particular standards, and so avoid overlapping of the same thing. There are a multitude of articles which can be standardised in an Engine works, for example: keys, shaft collars, spanners, piston rings, conecting-rod ends, valve gear rod

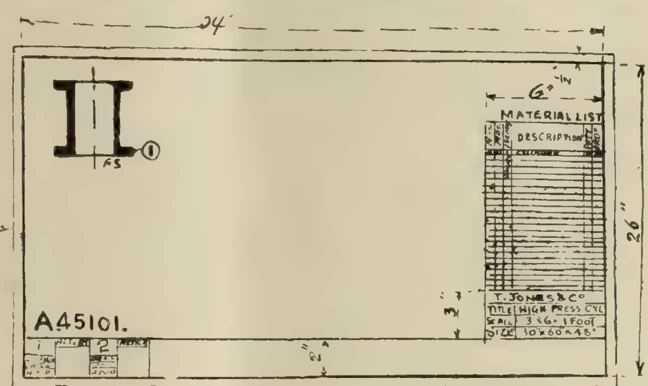


FIG. 3. DRAWING EXECUTION

ends, flange couplings, cast-iron pipe flanges, cast-iron bends and tees, cock handles, bolts and nuts, studs and nuts, tap bolts, and various kinds of screws to be stocked, rope pulley sections, stud unions for pipes, union couplings for pipes, standard pedestals, etc., etc.

Drawings Entering and Registration.

Drawings should, in the first instance, be entered into a drawing day book from which are taken the consecutive drawing numbers, and from this book two card indexes for reference should be compiled. One index is to be made up of cards and sub-cards according to the name of the part, properly alphabetically arranged as to size and type. The other index should be arranged according to engines, machines, or the whole article for which the drawings are required, the drawing lists serving the purpose of finding which drawings have been used for any particular order.

Figs. 1 and 2 show a drawer and a cabinet for these drawing index cards.

Drawing Sizes.

The drawings should with great advantage be kept to certain standard sizes, from which it should not be permissible to deviate. The following four sizes have been adopted in many engineering works:—

Size of sheet 26 in. × 39 in. to be called A sheet (see Fig. 3)
„ „ „ 19 in. × 26 in. „ „ „ B „
„ „ „ 13 in. × 19 in. „ „ „ C „
„ „ „ 8½ in. × 13 in. „ „ „ D „

These are the dimensions of the border-line of the drawing, and a half-inch cutting-off margin should be allowed all round.

Drawing Boards and Tables.

These are divided into two main categories: (1) the old-fashioned horizontal or slightly slanting drawing board resting on slightly tapered slides on a horizontal drawing table; and (2) the modern vertical or adjustable drawing table.

The horizontal drawing table should be twice the length of a drawing board, and the space on the right-hand side

of the board should be utilised to keep drawings of reference for immediate use. The part of the table under the drawing board should be left free in front for convenience of the knees when writing, but the left-hand part should contain a large drawer for putting away drawings in progress and other sketches, and one or two smaller drawers to contain books, instruments and drawing utensils. In connection with the horizontal fixed board, the parallel straight edge or the simplex pantograph combined Tee-square and scale are of great advantage, and a labour and time-saving appliance. The latter does away with much manipulation of Tee-square, set-square, and the finding of scales and rules (see Fig. 4).

Far better work can be got, however, out of the use of vertical boards, Fig. 5, throughout the drawing office, and their adoption soon pays for the initial high cost. The kind of board which is easily adjusted to any required angle and height is to be preferred. Those worked by levers, ratchets, and various other machinery it is advised to leave severely alone, as being a nuisance and very soon getting out of order. The cheapest board in this case is not the cheapest in the long run. The Tee-square on these boards is generally worked on the parallel principle and operated by a continuous and adjustable steel wire, working over

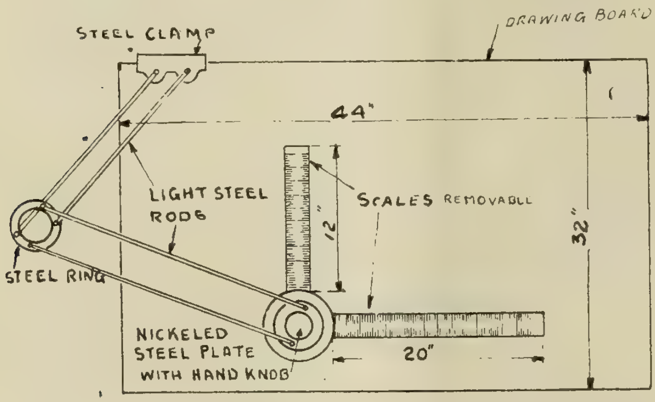


FIG. 4 PARALLEL MOTION T. SQUARE WITH SCALES

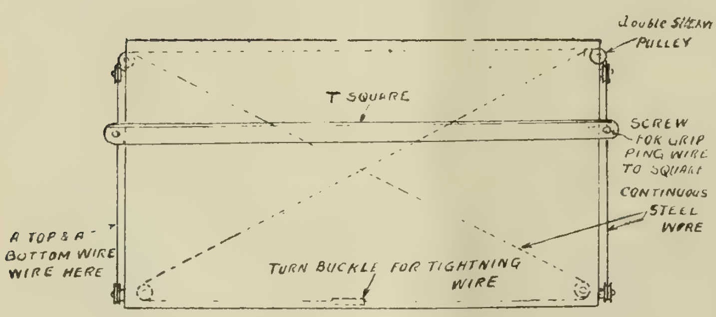


FIG. 4A. DRAWING BOARD WITH WIRE PARALLEL MOTION T SQUARE.

small brass pulleys. The Tee-square can be of hard wood with ebony edge, or, still better, of polished, trued thin steel about $\frac{1}{8}$ in thick. Both should have a substantial ledge to hold pencils and instruments handy when not in actual use. There are various clamping devices for holding down the drawing paper, but the use of drawing pins is, in most cases, preferable.

Drawing Instruments.

It has been found by experience, and is therefore to be strongly advised, that young lads intending to become draughtsmen should, when their time comes for buying drawing instruments, only buy the best make. A strong box containing a pair of dividers (hair or otherwise), large compasses with needle points and loose pencil and ink legs,

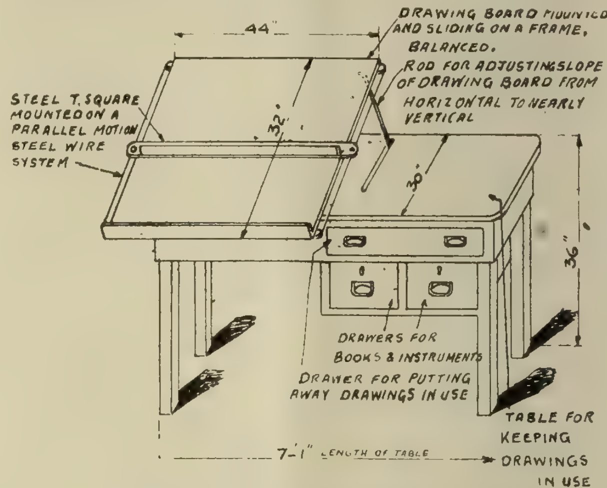


FIG. 5 THE ADJUSTABLE DRAWING TABLE

one or two inking pens, a small pair of compasses with needle points and loose pencil and ink legs, and a spring-bow set consisting of one pair of spring dividers without needle points and a pair of spring pencil bows with needle points, and a pair of spring ink bows with needle points, are all that are usually required.

To this may be added a pair of proportional compasses, which may prove very useful for certain classes of work. Further, a closely-divided rule of scales, either made of boxwood or white celluloid, in addition to a pair of set squares with 45 deg. and 60 deg. angles and a protractor are required. A lad thus equiped from the start should, with care, be able to keep these for a lifetime.

(To be continued.)

THE USE OF POWDERED FUEL FOR HEATING METALLURGICAL FURNACES AND FOR STEAM RAISING.

By J. S. Atkinson,

of the Powdered Fuel Plant Co. Ltd., London.

In the United States of America a considerable amount of attention has been given in recent years to the use of powdered fuel, most satisfactory results having been obtained. It is somewhat surprising that in this country the subject has received comparatively little attention.

Some twenty-three years ago powdered fuel was first used on an industrial basis for firing rotary kilns in connection with the manufacture of Portland cement. The application of powdered fuel to metallurgical furnaces and for steam-raising took place several years later. Powdered fuel is now being used most successfully for heating many different types of furnaces, amongst which may be mentioned open-hearth smelting furnaces, reheating furnaces, for both iron and steel, puddling furnaces, soaking pits, rotary kilns for the desulphurisation and roast-

ing of ore and also for nodulising flue dust. Both stationary and locomotive boilers are being fired with exceptionally good results with powdered fuel.

Powdered Fuel Past Experimental Stage.

The use of powdered fuel is long past its experimental stages, and in view of the great economy which can be realised, and other most important advantages obtainable, there is little question that its use will become general and will supplant to a very great extent all other methods, once the subject is fully understood by industrial users of fuel in this country.

Several different systems of powdered fuel application are in use in the United States, the principal being "The Holbeck," introduced by the "Bonnot" Co., of Canton, Ohio; "The Fuller," introduced by the Lehigh Car, Wheel and Axle Works; "The Aero-Pulverised" and "The Muhlfeld," this latter system being used in conjunction with locomotives.

The Holbeck System.

In this system the method employed is as follows: The coal is first passed through a crusher, which reduces its size to 1-in. cubes and under. If there are any particles of scrap iron mixed with the coal the latter is passed under a magnetic separator after leaving the crusher. After being crushed the coal is passed into a rotary dryer where the moisture is reduced to 1 per cent or less. From the dryer the coal passes to the pulverising mill, where it is ground to such a degree of fineness as to allow of 95 per cent of the total passing through a 100-mesh sieve and 85 per cent of the total through a 200-mesh sieve. All conveying of the coal to the crusher and from this to the rotary dryer and to the pulverising mill is effected by conveyors and elevators.

Should slack coal be available, containing only a small percentage of large lumps over 1-in. cube, the crusher is not required, the coal being sent direct to the rotary dryer after any particles of scrap iron have been extracted. From the pulverising mill the powdered coal is carried in suspension in an air current and delivered into a collector bin, the air being separated from the coal in this collector bin, the coal falling into a storage bin and the air being returned to the pulverising mill. From the storage bin the fuel is taken by an automatically-controlled screw feed and discharged into the distributing main. In this main it is met by a second current of air and is carried in suspension through the main. The distributing main is tapped at any desired point by branches leading to the different units, furnaces or boilers, required to be fired.

Any excess of powdered coal which is not used for firing the different units is returned through a return main to the collector bin, where it is extracted from the air and falls into the storage bin and is used over again.

The advantage of the "Holbeck" system is that widely-separated units can be fired from a central pulverising plant, without involving the use of mechanical conveyors for distributing the powdered fuel from the pulverising mill to the furnaces or boilers. Each furnace or boiler is fitted with a fuel burner or burners, according to requirements.

The Fuller System.

Comparing the "Fuller" system with the "Holbeck" system, the principal difference is that, in the case of the "Fuller" system, mechanical conveyors are used for feeding the powdered coal to each furnace or boiler, a storage bin being usually installed close to each unit to be fed. Otherwise the "Fuller" system is generally on the same lines as the "Holbeck" system. The "Fuller" system is perhaps more suitable when the units to be fired are situated near together and at a convenient distance from the pulverising plant.

Aero-Pulverised System.

This system works on the induced-draught principle; control of the coal and air is provided so that it can be used for delivering fuel direct to the units requiring heating. In this case one machine is placed at each furnace or boiler, and the central pulverising plant is done away with. In this system coal containing a high percentage of moisture can be burnt owing to the liberal clearances and the large amount of air passing through the machine at all times. It, however, must be remembered that the efficiency of burning powdered coal is greatly affected by the degree of moisture carried by the fuel.

Muhlfeld System.

With regard to the "Muhlfeld" system, as this is used mainly in conjunction with locomtives, we will not deal with the matter here.

High Efficiency in Fuel Consumption.

On the ordinary grate, either for metallurgical furnaces or boilers, and with hand firing, 100 per cent or more excess air is required for combustion owing to the uneven distribution of the air through the fuel. With mechanical stokers 50 per cent or more excess air is required. Complete combustion can be obtained with powdered fuel with 25 per cent excess air, and with careful control this percentage may be reduced to almost zero. The above fact is due to the even mixing of the air and coal, the required amount of air being in intimate relation with each particle of powdered coal.

The possibility of being able to burn powdered coal with a very small excess of air results in great fuel economy. In the case of gas producers, there is an initial loss of 20 per cent of the total heat units in the fuel; this is entirely eliminated with powdered fuel, as the entire heat value of the coal is utilised in the furnace or boiler.

Mr. Barnhurst, of the Fuller Engineering Co., in an address to the Engineers' Society of Western Transylvania, gives the following comparison, comparing the use of powdered coal with ordinary coal firing and furnaces fired with producer gas:—

"In Continuous Furnaces, for heating billets, 24 per cent has been saved."

"In Open Hearth Producer Gas-fired Furnaces 30 per cent to 35 per cent of coal has been saved."

"In Puddling Furnaces 33 per cent to 50 per cent saving has been shown in important furnaces."

"In Heating Furnaces and Bushelling Furnaces 20 per cent to 25 per cent of fuel is saved."

These figures are from authentic sources, and afford large ground for the assumption that pulverised coal has "made good," and has come to stay with us in our effort towards the best form of conservation of natural resources.

(To be continued).

GOVERNORS AND GOVERNING MECHANISM.

By A. Houlson.

(Continued from page 45.)

We have now to consider the weight of the pin, spring shackle and link ends, which have an aggregate weight of 8 lbs., and act at a distance of $6\frac{1}{4}$ in. from the datum line C D. The arm itself weighs 11 lbs., and its centre of gravity is 4.46 in. from the datum line.

From Fig. 37 we see how the centre of gravity of the complete arrangement is obtained, thus:—

Let x equal distance of required centre of gravity from the datum line C D.

Then $(11+8)x = 11 \times 4.46 + 8x\ 6.25.$

$$19x = 49 + 50.$$

$$x = 5.2 \text{ in.}$$

From this we find the travel at the centre of gravity of the arm (see Fig. 38), which gives us the value of R to be used in the formula for centrifugal force, viz., $F = WRN^2\ .00034$

where W = weight of one lever weight in pounds.
N = number of revolutions per minute.
R = radius in feet.

In this example W = 19, N varies as shown in Table 7, and R varies from .604 to .7 The travel of the throttle valve is $\frac{5}{8}$ in. The ratio of the bell crank lever is 1 to $1\frac{1}{2}$, giving $^{15}/_{16}$ in. travel of the sleeve, as shown in Fig. 38.

Referring to Table 7, the number 380, 400, and 420 indicate the number of revolutions per minute of the governor when running at its normal mean speed, respectively for the in, mid and out positions of the weight levers.

When the speed-adjusting spring is slackened to its fullest extent we have the minimum adjusted speed, 368 revolutions per minute, and when it is fully tightened up the maximum adjusted speed is obtained, viz., 432 revolutions per minute at mid-position. The five corresponding figures under the heading "Centrifugal Force" in the same table represent the centrifugal force produced in one weight at these various speeds, as found from the formula $F = WRN^2\ .00034$. This force acts at 5.2 inches from the fulcrum pin, the springs are attached at $6\frac{1}{4}$ in. from the same point. Therefore, under the heading "Spring Load" in the table the loads have been decreased in the ratio 6.25 to 5.2, thus giving the corresponding tensions in the springs.

From the table, we see that we have, for the in-position of governor weight at normal speed, a total

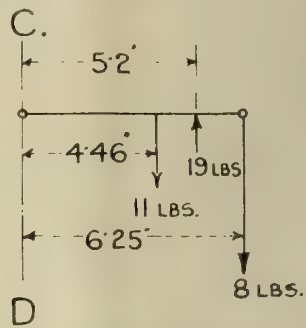


Fig. 37.—Governors.

tension on the springs of 469 lbs., and for the out-position 664 lbs.

As we require an initial load on the adjusting spring to give the necessary thrust on the pin joints, etc., the initial load should be apportioned thus: Three-quarters, or 352 lbs. on the main springs; one quarter, or 117 lbs. on the adjusting spring. This

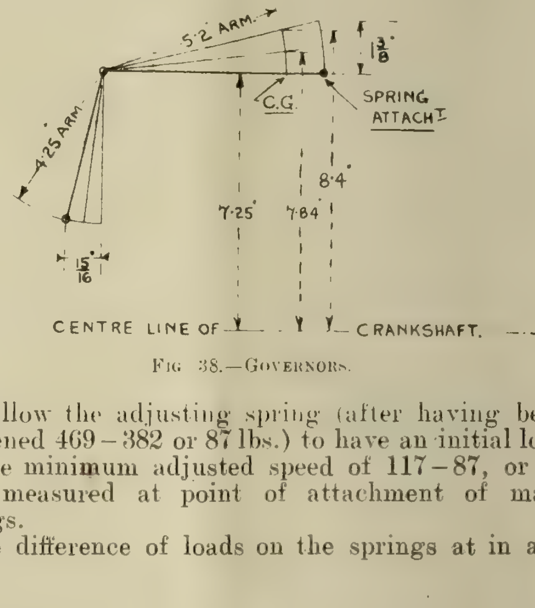


Fig. 38.—Governors.

will allow the adjusting spring (after having been slackened 469 − 382 or 87 lbs.) to have an initial load for the minimum adjusted speed of 117 − 87, or 30 lbs., measured at point of attachment of main springs.

The difference of loads on the springs at in and

TABLE 7.

Position.	Radius to Centre of Gravity Feet.	R.P.M. Minim'm Adjusted Speed.	R.P.M. Normal Speed.	R.P.M. Maxim'm Adjusted Speed.	Centrifugal Force at Centre of Gravity. Minim'm Adjusted Speed.	Centrifugal Force at Centre of Gravity. Normal Speed.	Centrifugal Force at Centre of Gravity. Maxim'm Adjusted Speed.	Aggregate Spring Load. Minim'm Adjusted Speed.	Aggregate Spring Load. Normal Speed.	Aggregate Spring Load. Maxim'm Adjusted Speed.	Load on Main Springs. On Two Springs.	Load on Main Springs. On One Spring.
Out.	·7	392	420	448	694	798	911	577	664	758	498	249
Mid.	·652	368	400	432	470	674	786	474	561	655	421	$210\frac{1}{2}$
In.	·604	343	380	417	459	564	677	382	469	563	352	176

out positions, viz., 664 − 469, or 195 lbs., must be similarly distributed between the main and the adjusting springs, *i.e.*, three-quarters, or 146 lbs., on the main spring; one quarter, or 49 lbs., on the adjusting spring.

In determining the sizes of the main springs, it must be remembered that the tension in same is merely that due to the centrifugal force of one weight lever only; the other weight lever forming the reaction. Also, as there are two main springs, the initial load on each $= \frac{352}{2} = 176$ lbs., and the final load $= \frac{352 + 146}{2}$, or 249 lbs.

The difference of tensions $= 249 - 176$, or 73 lbs. The travel of each weight lever at the point of attachment of springs is $1\frac{3}{8}$ in., hence the resulting extension of the spring is $2\frac{3}{4}$ in.; and the tension per inch of the spring is $\frac{73}{2{\cdot}75}$, or 26.4 lbs. per inch.

The initial extension of the spring is $\frac{176}{26{\cdot}4} = 6.66$ in.

The final extension of the spring is $6.66 + 2.75 = 9.41$ inches. The free length of the spring may be 5 in.; the diameter of wire being $^{11}/_{32}$ in.; then there will be sufficient room for the spring and the shackles between the governor weight levers at in-position; also the spring will not be quite solid when free. The outside diameter of coils will be $4\frac{1}{2}$ in., and there will be ten coils.

Turning our attention to the adjusting spring, if this spring were attached in such a manner that its movement was equal to the movement of the governor weights at point of attachment of main springs, then the difference of loads for this spring at in and out-position for normal speed of running would be 49 lbs., as already calculated, for one weight.

But the ratio of the movement of the point of attachment of the adjusting spring to the movement of the point of attachment of the main spring is 1 to 2.2; also the adjusting spring is acted upon by the centrifugal force of two governor weights. Therefore, the difference of loads at normal speed $= 2 \times 2.2 \times 49 = 216$ lbs.

The movement or compression of the adjusting spring for this difference of loads is .625 in., therefore the compression per inch is $216 \div .625 = 345$ lbs. The total load on the adjusting spring is made up as follows (loads measured at point of attachment of main springs):—

Initial load, 30 lbs. Compression for minimum adjusted speed, 87 lbs.; ditto for maximum adjusted speed, 94 lbs.; ditto for movement of weights, 49 lbs. Total for one governor weight $= 30 + 87 + 94 + 49 = 260$ lbs., so that the actual maximum load on the adjusting spring is $2 \times 2.2 \times 260 = 1{,}140$ lbs. The maximum compression $= \frac{1140}{345} = 3.3$ in.

The free length is $10\frac{1}{2}$ in. There are 15 coils $^{7}/_{16}$ in. wire, $2\frac{5}{8}$ in outside diameter of coils.

The formulæ used to determine the size of springs are as follows:—

Stress in wire $= f = \dfrac{16 \times W \times R}{\pi d^3}$

Deflection $= \dfrac{4 \times \pi \times R^2 \times n \times f}{c \times d}$

where W = maximum load of spring in lbs.
R = radius to centre of coils in inches.
d = diameter of wire.
C = 11,000,000 to 12,000,000.
n = number of coils.
f = should not exceed **75,000** lbs. per square inch.

The spring makers should be supplied with the following information:—

Maximum load on spring, tension or compression per inch deflection; maximum outside diameter; minimum inside diameter, free length, and allowed to fix up the size of wire, etc., according to their experience.

The controlling force of the governor is

$$561 \times 2 \times .02 \times 2.2 = 50 \text{ lbs. nearly.}$$

(To be continued.)

MODIFICATION TO STANDARD IRONCLAD SWITCHGEAR FOR SPECIAL CIRCUITS.

By J. F. Foley.

In a factory making standardised lines of ironclad apparatus, it will frequently be found difficult to exactly meet the requirements of purchasers whose supply system is out of the ordinary. It is obviously impossible, both from the cost and time point of view, to build special apparatus in these cases, at the same time bearing in mind to avoid turning down the prospective order whereever possible. It is therefore essential to adopt some simple method to overcome this, as in many cases larger contracts may be involved at a later date.

This article deals with a few brief proposed suggestions.

Direct Current—Negative Earthed System.

Example.—An ironclad motor-control panel is required to start up a 50-H.P. (horse power) 500-volt D.C. shunt-wound motor, on a negative earthed system. The incoming cable is concentric, and the outgoing leads to motor taken through conduit tubing. Should the efficiency of the motor be 90 per cent. the normal full-load current will be approximately 83 amperes. Assume the class of apparatus consists of an ammeter, switch and fuse-box, and motor starter. A single-pole switch and fuse would be correct, but owing to there not being such a large demand for this kind of apparatus, few electrical firms manufacture same for stock.

One standard practice, however, would be to supply a 100-ampere double-pole air-break switch; a single fuse would also be fitted on the positive side, and suitably wired. We must ensure that the switch blades break simultaneously, or that the blade on the negative pole should lag or break shortly after the positive. As an alternative to this, a smaller-capacity double-pole switch about 50 to 60-ampere size, and slightly modified, may be supplied. Both the top contacts should be connected together with a copper strap, the same also on the bottom side, thus placing the switch blades in parallel, the modification of this size of switch only being slight, and may be cheaper in several instances than that of a standard 100-ampere-capacity switch appropriated from stock.

Either of the above schemes would be in line with "Home Office Requirements."

Motor Starter.

A standard type of ironclad motor starter (faceplate pattern) may be supplied, fitted with a no-volt release *only* ; the overload coil is omitted, the fuse taking care of a short, or excessive current on the motor. Where the customer insists on having an overload release fitted in addition to the fuse, carbon rollers may be added at a little extra cost; it being essential to have some appliance to minimise the arc, which would occur when the overload coil trips, due to a short, or excessive load on the motor. Slow-motion device may be fitted to light or heavy service starters to prevent the operator starting up too quickly. The starter and switch and fuse-box should be lined with some fire-resisting material to prevent any arcing on to the cast-iron case. For 75 H.P. upwards, multiple lever starters are successfully used. Contactor gear is also used for starting up large D.C. motors where faceplate starters cannot do the work. Although the automatic contactor gear is more expensive, it makes a sound, reliable job, and is highly recommended for large D.C. motors.

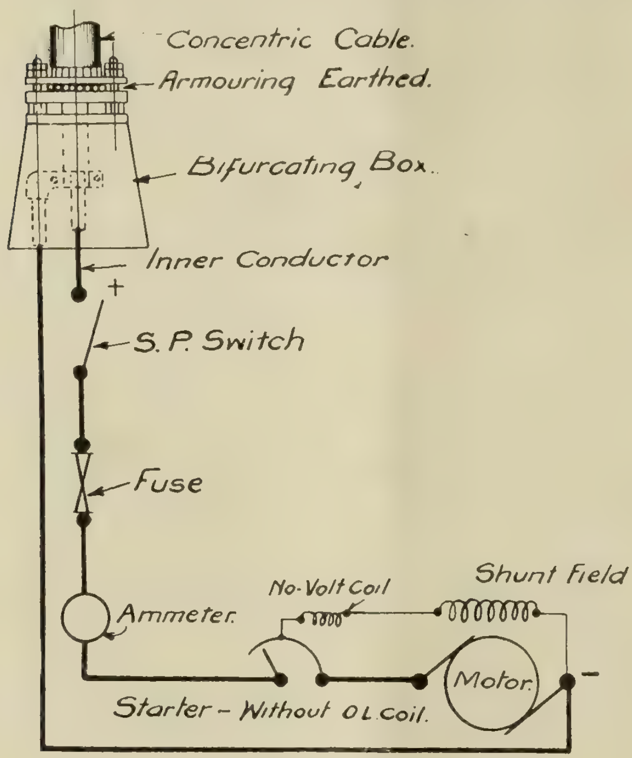


Fig. 1.

Fig. 1 shows a diagram of connection of the motor control panel for a D.C. negative earthed system in line with the first example.

In addition to the return cable being earthed at the generator end by means of an earthing plate, or other suitable method, the frame of the control panel, and motor, must also be earthed locally, this being independent of the negative earthed cable.

D. C. 3-Wire System.

On D.C. 3-wire circuits the voltage is usually 440 for power and 220 between inner and outer for lighting and small-power circuits. Assume a combined switch and fuse box is specified. A standard three-pole switch and fuse box containing three quick-break blades and two fuses may be supplied. The latter are inserted in the outer circuits. The middle incoming wire is earthed at the station.

As an alternative, where a combined switch and fuse-box cannot be supplied, a standard 2 or 3-pole quick-break ironclad switch bolted direct to a fuse box containing 3 fuses, the middle fuse-holder taken out, and replaced by a link (for testing purposes) made to fit the middle contacts, and neatly secured. In the latter case, the switchbox should be fitted with an interlock, so as to prevent the opening of the switch or fuse-box door unless the switch is in the "off" position, and, secondly, to prevent the closing of the switch with either doors open.

Two-phase 3-Wire System.

For starting up very small 2-phase motors, say up to 5 H.P., a direct starter (change-over switch) and fuse box, containing 2 fuses, is all that is necessary. For starting up 2-phase motors up to about 15 H.P., a series parallel switch and fuse box is often used. This switch is designed specially for these motors, which start up against one-third full-load torque, taking two to two-and-a-half times full-load current from the line. In operating this switch, the stator windings are grouped in series, and secondly in parallel. For starting up larger-size squirrel-cage motors, standard 3-pole, quick-break, single-throw switch (for isolating purposes) fuse box (fuses cut out of circuit at starting), combined with a standard 3-phase auto-transformer starter, slightly modified.

The only modification to the latter is in selecting a 3-phase starter from stock, and altering one or two internal-connections, this only being a few minutes extra work.

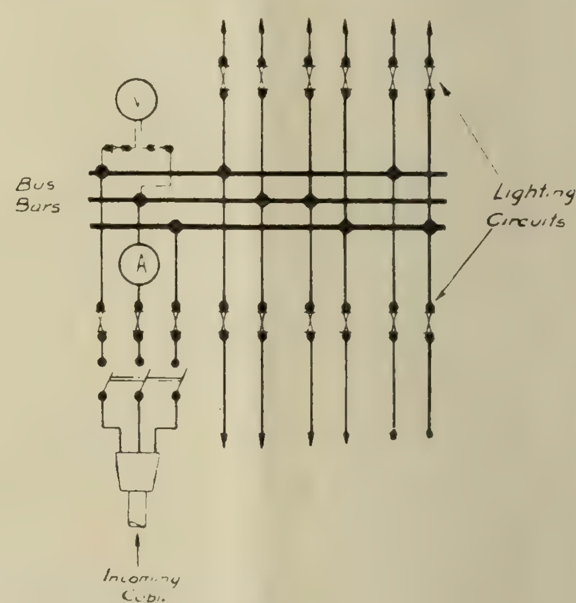


Fig. 3.

Another suggestion would be to supply a 3-pole oil switch fitted with two overload releases on the outer phases. The middle blade and contacts of the switch may be omitted if necessary, as is sometimes requested by the purchaser. In some cases where the neutral is *not* earthed and a standard 3-pole air-break switch and fuse is specified, care should be taken to wire the middle fuse $\sqrt{2}$ (1.4) times that of the current in the two outers. An auto-transformer starter to be supplied with the above switches, similar to that previously mentioned.

Two-phase 4-Wire System.

For starting up small 2-phase squirrel-cage motors on a 4-wire unearthed supply, a 4-pole change-over switch in a cast-iron box and a fuse box containing 4 fuses is the handle fixed midway between. Each of the fuse boxes which contain two fuses may be bolted to their respective switch box, and interlocked.

For starting up larger-size squirrel-cage motors,

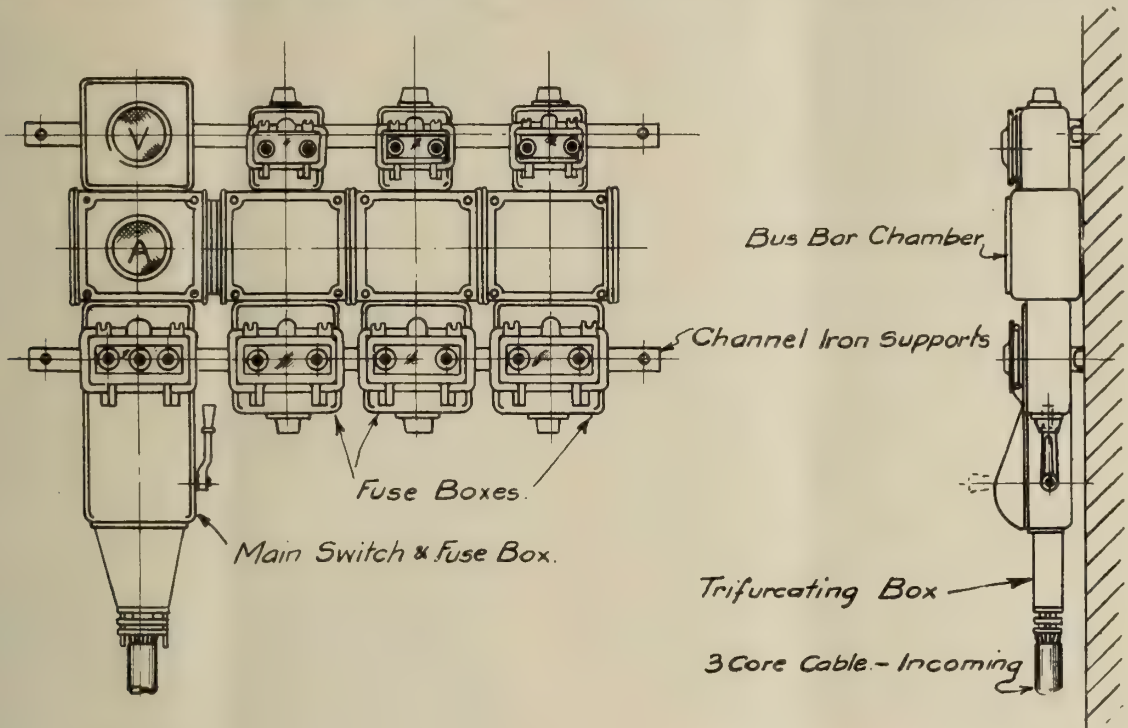


Fig. 2.

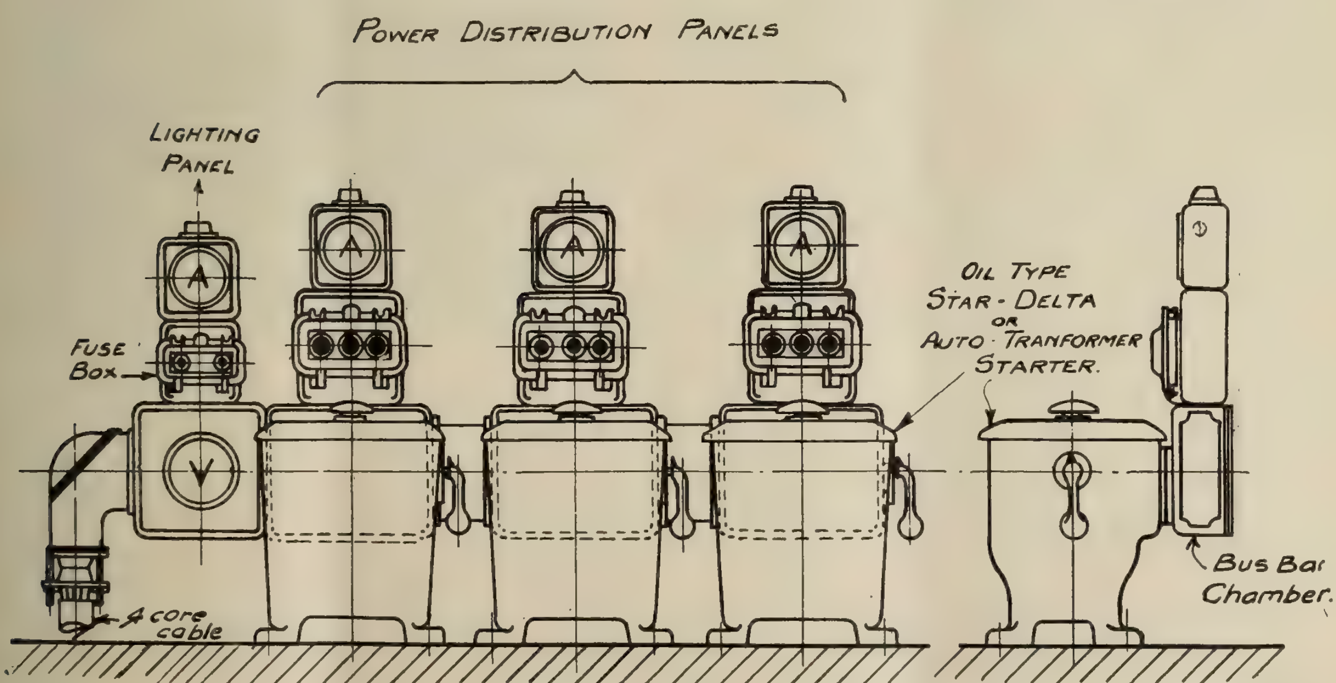


Fig. 4.

the usual practice. Where manufacturers have no 4-pole switches, or 4 fuses in a cast-iron box the following scheme will suffice:—

Couple two double-pole *double-throw* switches together by means of a special spindle running through both boxes, with couple two double-pole switches, as previously mentioned; they must be of the single-throw pattern, these being used for isolating purposes. In addition to the fuses, a standard 2-phase auto-transformer is required; the latter is designed specially for this system. The fuses should

be cut out at the starting, as also in the cases previously mentioned, when switching on the line with a change-over switch.

Where slip-ring motors are supplied, the fuses are inserted in the stator circuit and combined with a rotor starter. The latter is usually fitted with a no-volt release, with the coil connected across the switch blades on the stator side, so that in the event of the stator voltage dropping below a certain margin, the rotor starter will trip, and return to the "off" position.

Three-phase 3-Wire (for Lighting).

Example.—Assume a 6-way ironclad lighting distribution board is required, suitable for mounting on the wall approximately 6 ft. from the floor level. The following scheme is simple, and has a neat appearance:—

It consists of standard bus-bar chambers (fitted with 3 bus bars), fuse box (containing two fuses), ammeter and voltmeter, a 3-pole combined main switch and fuse box. The latter should be fitted on the underneath side of the chamber, so that in breaking the switch the whole of the board (including bus bars, meters, and fuses) are isolated.

"Home Office Pattern Fuses" should be supplied; distribution switches are then dispensed with.

There are several makes of fuses in line with "Home Office Requirements."

The great feature is in being able to insert a new fuse-holder after a fuse has blown without fear of the operator receiving a shock.

Fig. 2 shows an outline of an ironclad distribution board for 3-phase 3-wire system. The diagram of connections for same is depicted in Fig. 3.

Three-phase 4-Wire System or Three-phase 3-Wire with Earthed Neutral.

This system is frequently used for combined lighting and power boards. In some cases a 4-core incoming cable is taken from the low-tension side of the transformer, the neutral wire being earthed on the transformer.

When one lighting panel only is supplied, it will be connected between the neutral wire and one of the other phases. The cable may be taken direct to the bottom of the fuse terminals. For two or more lighting circuits, extra bus bar and chambers may be added at a little extra cost. The power circuits are connected in the usual manner as in 3-phase 3-wire system.

The line terminals of the star delta or auto-transformer starter are connected direct on to the bus bars, both being designed to break on load. Six leads are taken to the motor for star delta starting, and three leads when an auto-transformer is used.

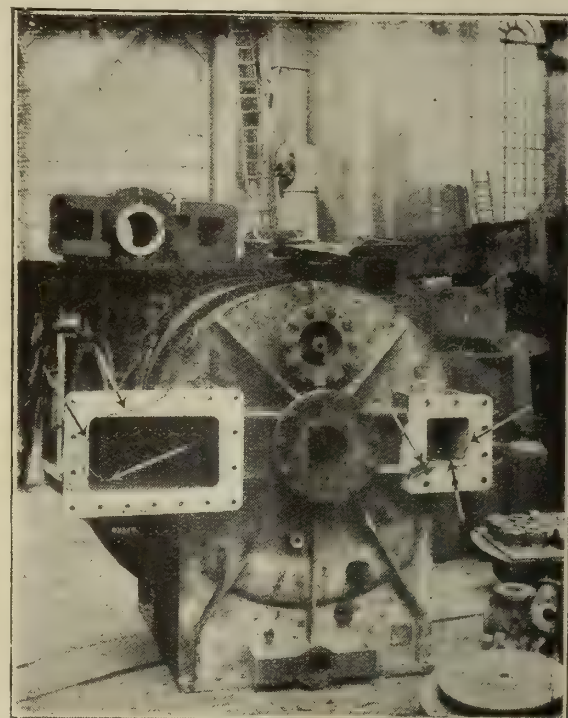
Fig. 4 shows an outline of a combined power and lighting ironclad distribution board suitable for floor fixing.

The Mining Industry in Tunisia.—The working of the mines here gave the following results in 1917:—Lead, 41,400 tons; zinc, 15,000 tons; iron, 606,000 tons; manganese, 5,800 tons; phosphate of lime, 1,000,000 tons; lignite, 32,700 tons; this represents a total value of over 67 million francs. It is hoped that, in 1918, the production of lignite will amount to from 70,000 to 75,000 tons. Prospecting is now being carried on at Utique with a view to locating reported petroleum springs, and very good results are being secured. After sinking three shafts, two of which attain a depth of about 60 metres and the third of 85 metres, work has been temporarily suspended, the sea-level having been attained. Work will not be resumed until the boring plant ordered has been received from Europe.

WELDING LARGE ENGINE CYLINDERS.

At the moment when shipbuilders and ship repairers are straining every nerve on both sides of the Atlantic to increase output, an illustration of what can be done by scientific welding is particularly appropriate. The low-pressure, high-pressure, and intermediate cylinders of a triple-expansion marine engine of the approximate weight of 30 tons, belonging to a large vessel, were badly fractured. Barimar Ltd., the London scientific welders, were asked to inspect the cylinders with the view to repair, and they promptly undertook the work, using during the operations 21,000 feet of acetylene and 30,000 feet of oxygen, with which to heal fractures extending over a length of some 14 ft. 6 in., with a thickness of metal averaging 3 in.

Some idea of the importance of this work may be



Welding Large Engine Cylinders.

gathered from the fact that the approximate values of the complete engine were £150,000, and the three cylinders repaired £50,000, but such is the condition of affairs that replacements were absolutely unobtainable.

Notwithstanding the severe injuries sustained by the cylinders, skilled welders were able to make perfectly satisfactory repairs within a period of five days at a small insignificant fraction of the original cost of the parts, and the work, which was done in an important North British yard, was duly approved by Lloyd's officials.

Fortunate it is that Barimar experts were able to make good. The only alternative would have been to prepare new designs, new patterns and castings, involving the laying-up of the ship for perhaps six months or more.

Weights of Lengths of Rolled Steel Sections.

Beam 18 in. × 6 in. × 55 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 3 18	9 3 8	14 2 26	0 19 2 16	1 4 2 6	1 9 1 24	1 14 1 14	1 19 1 4	2 4 0 22	0
1	0 1 27	5 1 17	10 1 7	15 0 25	1 0 0 15	1 5 0 5	1 9 3 23	1 14 3 13	1 19 3 3	2 4 2 21	1
2	0 3 26	5 3 16	10 3 6	15 2 24	1 0 2 14	1 5 2 4	1 10 1 22	1 15 1 12	2 0 1 2	2 5 0 20	2
3	1 1 25	6 1 15	11 1 5	16 0 23	1 1 0 13	1 6 0 3	1 10 3 21	1 15 3 11	2 0 3 1	2 5 2 19	3
4	1 3 24	6 3 14	11 3 4	16 2 22	1 1 2 12	1 6 2 2	1 11 1 20	1 16 1 10	2 1 1 0	2 6 0 18	4
5	2 1 23	7 1 13	12 1 3	17 0 21	1 2 0 11	1 7 0 1	1 11 3 19	1 16 3 9	2 1 2 27	2 6 2 17	5
6	2 3 22	7 3 12	12 3 2	17 2 20	1 2 2 10	1 7 2 0	1 12 1 18	1 17 1 8	2 2 0 26	2 7 0 16	6
7	3 1 21	8 1 11	13 1 1	18 0 19	1 3 0 9	1 7 3 27	1 12 3 17	1 17 3 7	2 2 2 25	2 7 2 15	7
8	3 3 20	8 3 10	13 3 0	18 2 18	1 3 2 8	1 8 1 26	1 13 1 16	1 18 1 6	2 3 0 24	2 8 0 14	8
9	4 1 19	9 1 9	14 0 27	19 0 17	1 4 0 7	1 8 3 25	1 13 3 15	1 18 3 5	2 3 2 23	2 8 2 13	9

Weight of Beam advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight
	4·58	9·16	13·75	18·33	22·92	27·5	1 4·08	1 8·67	1 13·25	1 17·84	1 22·42	1 27·0	

Weights of Lengths of Rolled Steel Sections.

Beam 18 in. × 6 in. × 55 lbs. per foot.

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Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 9 0 12	4 18 0 24	7 7 1 8	9 16 1 20	12 5 2 4	14 14 2 16	17 3 3 0	19 12 3 12	22 1 3 24	0
10	0 4 3 18	2 14 0 2	5 3 0 14	7 12 0 26	10 1 1 10	12 10 1 22	14 19 2 6	17 8 2 18	19 17 3 2	22 6 3 14	10
20	0 9 3 8	2 18 3 20	5 8 0 4	7 17 0 16	10 6 1 0	12 15 1 12	15 4 1 24	17 13 2 8	20 2 2 20	22 11 3 4	20
30	0 14 2 26	3 3 3 10	5 12 3 22	8 2 0 6	10 11 0 18	13 0 1 2	15 9 1 14	17 18 1 26	20 7 2 10	22 16 2 22	30
40	0 19 2 16	3 8 3 0	5 17 3 12	8 6 3 24	10 16 0 8	13 5 0 20	15 14 1 4	18 3 1 16	20 12 2 0	23 1 2 12	40
50	1 4 2 6	3 13 2 18	6 2 3 2	8 11 3 14	11 0 3 26	13 10 0 10	15 19 0 22	18 8 1 6	20 17 1 18	23 6 2 2	50
60	1 9 1 24	3 18 2 8	6 7 2 20	8 16 3 4	11 5 3 16	13 15 0 0	16 4 0 12	18 13 0 24	21 2 1 8	23 11 1 20	60
70	1 14 1 14	4 3 1 26	6 12 2 10	9 1 2 22	11 10 3 6	13 19 3 18	16 9 0 2	18 18 0 14	21 7 0 26	23 16 1 10	70
80	1 19 1 4	4 8 1 16	6 17 2 0	9 6 2 12	11 15 2 24	14 4 3 8	16 13 3 20	19 3 0 4	21 12 0 16	24 1 1 0	80
90	2 4 0 22	4 13 1 6	7 2 1 18	9 11 2 2	12 0 2 14	14 9 2 26	16 18 3 10	19 7 3 22	21 17 0 6	24 6 0 18	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	Weight
	24 11 0 8	49 2 0 16	73 13 0 24	98 4 1 4	122 15 1 12	147 16 1 20	171 17 2 0	196 8 2 8	220 19 2 16	245 10 2 24	

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Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 20 in. × 6¼ in. × 65 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	5 3 6	11 2 12	0 17 1 18	1 3 0 24	1 9 0 2	1 14 3 8	2 0 2 14	2 6 1 20	2 12 0 26	0
1	0 2 9	6 1 15	12 0 21	0 17 3 27	1 3 3 5	1 9 2 11	1 15 1 17	2 1 0 23	2 7 0 1	2 12 3 7	1
2	1 0 18	6 3 24	12 3 2	0 18 2 8	1 4 1 14	1 10 0 20	1 15 3 26	2 1 3 4	2 7 2 10	2 13 1 16	2
3	1 2 27	7 2 5	13 1 11	0 19 0 17	1 4 3 23	1 10 2 29	1 16 2 7	2 2 1 13	2 8 0 19	2 13 3 25	3
4	2 1 8	8 0 14	13 3 20	0 19 2 26	1 5 2 4	1 11 1 10	1 17 0 16	2 2 3 22	2 8 3 0	2 14 2 6	4
5	2 3 17	8 2 23	14 2 1	1 0 1 7	1 6 0 13	1 11 3 19	1 17 2 25	2 3 2 3	2 9 1 9	2 15 0 15	5
6	3 1 26	9 1 4	15 0 10	1 0 3 16	1 6 2 22	1 12 2 0	1 18 1 6	2 4 0 12	2 9 3 18	2 15 2 24	6
7	4 0 7	9 3 13	15 2 19	1 1 1 25	1 7 1 3	1 13 0 9	1 18 3 15	2 4 2 21	2 10 1 27	2 16 1 5	7
8	4 2 16	10 1 22	16 1 0	1 2 0 6	1 7 3 12	1 13 2 18	1 19 1 24	2 5 1 2	2 11 0 8	2 16 3 14	8
9	5 0 25	11 0 3	16 3 9	1 2 2 15	1 8 1 21	1 14 0 27	2 0 0 5	2 5 3 11	2 11 2 17	2 17 1 23	9

Weight of Beam advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight	lbs.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight
	5·42	10·84	16·26	21·67	27·1	1 4·6	1 10	1 15·4	1 20·8	1 26·2	2 3·6	2 9	

Weights of Lengths of Rolled Steel Sections.

Beam 20 in. × 6¼ in. × 65 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 18 0 4	5 16 0 8	8 14 0 12	11 12 0 16	14 10 0 20	17 8 0 24	20 6 1 0	23 4 1 4	26 2 1 8	0
10	0 5 3 6	3 3 3 10	6 1 3 14	8 19 3 18	11 17 3 22	14 15 3 26	17 14 0 2	20 12 0 6	23 10 0 10	26 8 0 14	10
20	0 11 2 12	3 9 2 16	6 7 2 20	9 5 2 24	12 3 3 0	15 1 3 4	17 19 3 8	20 17 3 12	23 15 3 16	26 13 3 20	20
30	0 17 1 18	3 15 1 22	6 13 1 26	9 11 2 2	12 9 2 6	15 7 2 10	18 5 2 14	21 3 2 18	24 1 2 22	26 19 2 26	30
40	1 3 0 24	4 1 1 0	6 19 1 4	9 17 1 8	12 15 1 12	15 13 1 16	18 11 1 20	21 9 1 24	24 7 2 0	27 5 2 4	40
50	1 9 0 2	4 7 0 6	7 5 0 10	10 3 0 14	13 1 0 18	15 19 0 22	18 17 0 26	21 15 1 2	24 13 1 6	27 11 1 10	50
60	1 14 3 8	4 12 3 12	7 10 3 16	10 8 3 20	13 6 3 24	16 5 0 0	19 3 0 4	22 1 0 8	24 19 0 12	27 17 0 16	60
70	2 0 2 14	4 18 2 18	7 16 2 22	10 14 2 26	13 12 3 2	16 10 3 6	19 8 3 10	22 6 3 14	25 4 3 18	28 2 3 27	70
80	2 6 1 20	5 4 1 24	8 2 2 0	11 0 2 4	13 18 2 8	16 16 2 12	19 14 2 16	22 12 2 20	25 10 2 24	28 8 3 0	80
90	2 12 0 26	5 10 1 2	8 8 1 6	11 6 1 10	14 4 1 14	17 2 1 18	20 0 1 22	22 18 1 26	25 16 2 2	28 14 2 6	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight
	29 0 1 12	58 0 2 24	87 1 0 8	116 1 1 20	145 1 3 4	174 2 0 16	203 2 2 0	232 2 3 12	261 3 0 24	290 3 2 8	

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ENGINEERING APPOINTMENTS OPEN.

TRADE ITEMS, NOTES, &c.

NICKEL IN NEW CALEDONIA. At Point Chaleix, near Noumea, there are now being erected large blast furnaces for smelting nickel. The leading spirits of the concern are Australian and Japanese experts.

NEW STEELWORKS, ETC., IN HOLLAND. The Second Chamber of the General Dutch States has just passed a Bill authorising the Government to participate in the establishment of steel foundries and rolling mills in Holland. It is proposed to float a joint-stock company with a capital of 25 million florins. Work will not be commenced till peace has been concluded; the coal required will be obtained from the Limburg mines.

ELECTRIC STEEL PRODUCTION. A recent development in the metallurgical industry which merits comment is the very great increase in the production of steel made by electric furnaces. According to Professor Carpenter, F.R.S., of the Imperial College of Science and Techology, previous to the war the output was so small that it did not figure in any returns of steel production. Nevertheless, in 1917 no less than 110,000 tons of electric steel were made, of which 90,000 tons were in the form of ingots and 20,000 tons in castings. At the present time upwards of 50 furnaces are at work in the various Sheffield works.

ENEMY AIRCRAFT EXHIBITION. The exhibition of enemy aircraft at the Agricultural Hall, Islington, was opened to the public on the 15th Nov. Numerous types of machines were on view, which showed not only their external features, but also their actual construction. Amongst other famous aircraft on exhibition were the Gotha, Freidrichshafen, and A.E.G. bombing planes; the Halberstadt, L.V.G., D.F.W., Rumpler, and Hanneveraner two-seater; the A.E.G. armoured trench fighter two-seater; and the Fokker, Pfalz, and Albatross scouts. There was also a complete array of engines and accessories, including wireless gear, machine-guns, bomb-sights, electrically-heated clothing, and innumerable aviation instruments.

NEW AMERICAN AUTOMATIC TRAIN STOP. This device, invented by Mr. Schweyer, was exhibited in operation before a large company of railway officials and others on the Philadelphia and Reading Railway on Sunday, June 23rd. In this system an electric current (alternating) controlling air-brake valves on the locomotive is run through a choke coil, which is so fixed on the engine frame as to move in line with a "track armature" 30 in long, fastened on the sleepers 13 in. outside the gauge line. The choke coil and the track armature are $2\frac{1}{4}$ in. apart, and there is nothing movable in either of them. On the passage of a train the armature weakens the current on the engine, and thus causes the setting of the brakes. A roadside battery, in connection with a short section of insulated track and an insulated truck of the locomotive, is arranged so as to neutralise this stop-operation, as may be desired, whenever the track ahead is clear. The tests were made under all three of the normal conditions—clear, caution, and stop. The caution indication was arranged to reduce speed but not to stop the train, and the stop indication was arranged to apply the brakes in emergency. In the caution test, a service application of 15 lb. reduction was made, which resulted in a reduction of speed from approximately 35 miles an hour to about 20 miles an hour before the next ramp (track armature) was reached. This test was not considered satisfactory, and it was repeated, with a service application of 25 lb. reduction. This application reduced the speed gradually from about 35 miles an hour until the train reached the next ramp, when it was brought to a stop in less than 100 ft. The test for a full stop was made at the entrance of the signal section, and there was no preliminary caution signal, with its ramp to give the customary reduction of speed. The speed over this ramp was approximately 35 miles an hour, and the train was brought to a stop in 700 ft. with the throttle open. After the regular tests were completed, a number of runs were made to test the electro-magnetic fixture which is placed between the rails, and is designed for use on an electrified railway in place of the insulated track section. These tests, like the others, fully met expectations and requirements.

POWER SAVING PLANT.

The State Administrative Engineers of the United States Fuel Administration recently held a conference in Washington, discussing the plan of organisation in connection with conservation of fuel in power plants throughout the United Statees.

This plan, which might well be copied elsewhere, is the result of conferences with the Federal Administrators and their committees for the group of States which together consume about 70 per cent of all coal used in the United States, exclusive of railroads. It has received the endorsement of all these States, as well as approval by the United States Bureau of Mines and the Committee on Consulting Engineers on Conservation and Publicity, which represents the engineering council of the four national engineering societies.

The slogan of the campaign is "Maximum Production with Minimum Waste." The object is to operate all industries at full capacity, but to make every pound of fuel perform maximum service.

In laying the foundations for the organisation it has been anticipated that this work should become a permanent service of the Government.

Ten to 20 per cent, that is, from 25 to 50 million tons of coal per year can be saved by correct operation of steam power plants, using their present equipment, and without installation of new apparatus.

It is considered most important that all existing fuel conservation committees, committees of Chambers of Commerce and National Defence, manufacturers' associations and other bodies be continued in full force, and that the co-operation of such organisations be obtained.

The administrative engineer in each State will work under the supervision of the present Federal Administrator. No separate or new organisation is contemplated, but sufficient addition to the working force in each State will be made to ensure sufficient execution of the new function.

The National plan comprises certain fundamentals, as follows:

1—Personal inspection of every power plant in the country.

2—Classification and rating of every power plant, based upon the thoroughness with which each owner of said plant conforms to recommendations.

3—Responsibility of rating the plants will fall upon the administrative engineer in each State; the rating to be based upon reports of inspectors, who will not express opinions, but will collect definite information. The State fuel administrator in his judgment may entirely or partially shut off the supply of coal to any needlessly wasteful plant in his territory.

4—Inspectors are to be furnished from one or more of the following sources: A—Inspectors of the steam boiler insurance companies; B—State factory inspectors; C—Engineering students from technical colleges: D—Volunteers and others.

The ratings will be based upon recorded answers to questions, each of which will be given a value depending upon its relative importance to the other questions. Depending upon the efficiency of methods in use in any plant, it may be rated in Class 1, 2, 3 or 4.

The administrative engineer in each State will have supervision of electrical and mechanical problems connected with fuel conservation activities contemplated under this plan.

The ratings will be based upon existing equipment. The difficulty, delay and expense involved in the installation at this time of improved power equipment is fully recognised, but experience has proved that 10 to 20 per cent of fuel now used in power plants can be saved by improvements in operation alone.

In advance of the first inspection a questionaire is being sent to every power plant in each district, with notice to the owner that within, say sixty days, his plant will be inspected personally and the questionaire will be checked up by the inspector upon his visit. This action will give a reasonable time to any plant owner to improve the operation of his plant and conform to recommendations before his plant is actually rated. Thus when the inspector calls for the purpose of obtaining and checking up the information form, the plant may receive a much higher rating than would have been the case if no time were allowed between the sending and collecting of the questionaire.

It is recommended that a board of competent engineers be attached to the conservation committee in each State; also, a corps of lecturers to arouse public interest and disseminate engineering information.

The Fuel Administration has prepared a 50-minute film of moving pictures, showing good and bad operation in the steam boiler plant, methods of testing boilers, etc. These pictures will be available to each State in connection with its educational propaganda.

The Administration is also preparing a series of official bulletins on engineering phases of steam and fuel economics. Some of these are now ready for printing. They will include :—

1—Boiler and Furnace Testing.
2—Flue Gas Analysis.
3—Saving Steam in Heating Systems.
4—Boiler Room Accounting Systems.
5—Saving Steam and Fuel in Industrial Plants.
6—Burning Fine Sizes of Anthracite.
7—Boiler Water Treatment.
8—Oil Burning.
9—Stoker Operation.

In addition to this service, a list has been prepared in Washingson of competent engineers for each State, and is available for use of each local Administration. As the work develops, still further constructive assistance is contemplated for helping owners to bring their plants up to a high plane of economic operation.

DURABILITY OF CONCRETE SHIPS.

One of our daily contemporaries innocently announces, on the authority of a telegraphic message from the United States, "the discovery of a new protective coating, which is expected to make concrete ships as durable as steel." The misapprehension here involved would be simply amusing if it were not calculated to give the uninitiated a false idea of the relative durability of the two materials. Engineers and shipbuilders are, of course, quite aware of the fact that concrete is everlasting as compared with so corrodible a metal as steel, and that protective coatings are quite unnecessary for ships, except to prevent the adhesion of marine growths. Concrete which is correctly proportioned and carefully prepared is impermeable, and will endure for all time.

MODERN STEAM TURBINES.

By J. Humphrey.

(Continued from page 32.)

Other Types of Turbines.

The turbines considered up to the present are all high-pressure machines, such as are used for driving electric generators in power stations, but there are various other kinds of turbines, known as low pressure, mixed pressure, back pressure, and reducing turbines, designed with a view to meeting various industrial requirements. Professor Rateau was the first to call attention to the possibilities and advantages of low-pressure turbines, and in order to allow low-pressure steam to be taken from an intermittently working machine at a constant or approximately constant rate he invented his well-known heat accumulator. Owing to their inherent design and the absence of slide valves and ports, and owing to the fact that the steam is constantly in motion, turbines can be designed to accommodate very large volumes of steam at the lowest pressures without entailing a great increase in cost. Great advantages can often be derived from the use of turbines in connection with reciprocating engines or other steam-using devices, for it is in this way possible to extract a very considerable amount of the total energy in the steam by expanding it down to the lowest practicable limit. When a low-pressure turbine is used in conjunction with a reciprocating engine, it is connected between the exhaust of the engine and the condenser and in electric power stations where the load on engines is not, of course, intermittent, no heat accumulator is required. It is advisable, however, to pass the exhaust steam from the engine through an oil separator, which also acts as a water separator. From steam tables giving the available energy in steam at various pressures it will be seen that when dry saturated steam is expanded from a boiler pressure of 150 lbs. per square inch to atmospheric pressure, the available energy amounts to 176 B.Th.U.s per pound of steam, and further, when expanded from atmospheric pressure to a vacuum of 28 inches the extra available energy is about 148 B.Th.U.s per pound, so that theoretically there is nearly as much work available in the low-pressure range as in the high. With a fairly economical reciprocating engine it is usual in practice, after allowing for condensation in the exhaust pipe, to obtain from the exhaust steam about 75 per cent of the output of the existing engine, but this figure is naturally increased if the engine be uneconomical. Of course, this gain applies to cases where a low-pressure turbine is coupled to an engine that was originally working non-condensing; but experience proves that there is a distinct gain to be derived by installing a low-pressure turbine in conjunction with a reciprocating engine with an existing condenser. With most condensing engines the saving over non-condensing conditions does not exceed 30 per cent under the most favourable load conditions, whilst on overloads the saving is smaller: but it has been found that where exhaust steam turbines have been applied to existing engines the total output has been increased by about 30 or 40 or even 50 per cent without any increase in the fuel consumption. In most cases where reciprocating engines are already in use the installation of an exhaust steam turbine will result in marked economy, irrespective of whether the existing engines are working condensing or not, although, of course, the greatest benefit is derived when the existing engines are working non-condensing.

The Application of Pure Low-Pressure Turbines.

The main application of pure low-pressure turbines is at present in connection with steam engines running in power stations. Engines are made to exhaust into the low-pressure turbine, which in turn exhausts into a condenser. Usually the combined set is arranged so that the normal full load of the engine alone when exhausting against a back pressure of about 16 lbs. per square inch is kept the same as before, and the low-pressure steam coming from the engine is utilised by the turbine. Clearly, the additional load that can be obtained from the turbine is determined mainly by the vacuum, and as a rule the improvement in economy is larger in places where river water is available than in places where cooling towers are necessary.

As far as the exterior appearance is concerned, low-pressure or exhaust steam turbines do not differ to any marked extent from high-pressure turbines, but they are somewhat shorter, and the exhaust pipes and valves are made larger to enable them to deal with the large volumes of steam, the quantity of steam dealt with being, roughly, twice that required by a high-pressure turbine of corresponding output. The Westinghouse Company supplies low-pressure turbines of the impulse type, built on the Rateau principle, and the constructional details are very similar to those of the Company's high-pressure Rateau turbines, already described, although there are fewer blade wheels and diaphragms. Overload valves are not, as a rule, fitted to exhaust steam turbines, but where circumstances render them particularly desirable they can, of course, be provided. The standard practice, however, is simply to fit a main stop valve and a governor. This type of exhaust steam turbine is applicable to those cases where the quantity of exhaust steam to give the required output is restricted and where the power to be obtained is large, and warrants the capital outlay. There are, however, cases where the gain to be effected by the installation of an exhaust steam turbine is small, unless the capital outlay is small, and where there is more exhaust steam than is sufficient to produce the desired amount of power, thus rendering steam economy of secondary importance, and to meet such cases the British Westinghouse Company has developed a very simple turbine, having a single velocity wheel with two rows of impulse blades. Unless there is always a supply of exhaust steam that is sufficient to carry the load a reducing valve should be provided to reduce the boiler steam to atmospheric pressure, so that steam delivered directly from the boilers can be used. If, however, it is necessary to run low-pressure turbines with boiler steam for long periods the losses due to throttling are too large, and in such cases a mixed pressure turbine is necessary. With exhaust steam turbo-plants a good vacuum is obviously of great importance, for the lower the absolute pressure the more rapidly are heat units surrendered. The energy given up between a 28 in. and a 29 in. vacuum

(corresponding to 1 lb. absolute and .49 lb. absolute) is more than that given up between a vacuum of 27 in. and 28 in. (corresponding to 1.48 lb. and 1 lb. absolute). Reciprocating engines are unable to take advantage of these very low pressures, but a turbine is able to do so with great efficiency. There is little doubt, however, that in many cases a mixed pressure turbine is preferable to a pure exhaust steam turbine, although the latter is quite satisfactory when used in conjunction with a reciprocating engine and when the two machines work as a single unit, and are controlled only by the engine governor whilst the two electric generators run in parallel. Under these conditions no heat accumulator is required, and it is unnecessary to admit steam to the turbine through a reducing valve. In other cases the merits of mixed pressure turbines are well worth considering.

Mixed-Pressure Turbines.

Mixed pressure turbines are high-pressure turbines with an additional inlet for low-pressure steam or low-pressure turbines, with additional high-pressure stages to utilise high-pressure steam when the quantity of low-pressure steam available is insufficient to deal with the load. Such turbines are used extensively in collieries and rolling mills, and utilise low-pressure steam coming from different kinds of engines, which exhaust against a back pressure of about 16 lbs. per square inch into steam accumulators. In these cases a heat accumulator is essential between the engine and turbine, so as to bridge over the period of rest of the engines and ensure a constant supply of steam to the turbine. The British Thomson-Houston Co. supplies a special valve, which is connected between the engine and the accumulator, and which, during the period whilst the engine is at rest, shuts off as soon as the pressure in the accumulator drops below that of the atmosphere. If the turbine runs in conjunction with a winding engine at a colliery, for instance, the use of such a valve prevents the engine being subjected to a variable back pressure, and the introduction of air through leakage is prevented. But when the period of rest is finished, and the engine begins to exhaust steam again, the valve opens, thus charging the accumulator up to a pressure of about 3 lbs. above atmospheric pressure, and if the engine continues to run after this pressure has been reached, an automatic valve on the accumulator opens to the atmosphere and discharges the surplus steam. Throughout the period of rest the turbine draws its steam from the heat accumulator, the pressure in which being often lowered to 10 lbs. absolute, so that the accumulator has a working pressure range of about 5 to 7 lbs., and consequently a great heat storage capacity. In the event of the supply of low-pressure steam being insufficient to cope with the load, the speed of the turbine slightly drops, and the high-pressure valves begin to open, but they close again immediately the supply of low-pressure steam is available. This arrangement works satisfactorily where the turbo-generator supplies current singly or in parallel with another machine of about the same capacity, and receiving a similar supply of steam; but if the mixed pressure turbine supplies power to a large system of which it forms only a small unit, the synchronising force of the other machines, working on an alternating-current system, prevents sufficient change of speed to permit of the governor opening the high-pressure valves when the low-pressure steam supply becomes insufficient. In these cases the governor gear of the British Thomson-Houston turbine is provided with an additional controlling device, which operates under the influence of the variations of pressure in the low-pressure steam pipe. As soon as the pressure drops to a predetermined point a diaphragm, which is normally balanced against a spring or against atmospheric pressure, is caused to extend and set the governor levers so that high-pressure steam is admitted, although the speed remains constant. When the accumulator is unsuitable for dealing with pressures below that of the atmosphere, it is advisable to couple an automatic shut-off valve between the turbine and the accumulator, for in the absence of such a valve it is possible in the event of a prolonged period of rest on the part of the main engine for the turbine to unduly lower the pressure in the accumulator, thus tending to cause inward leakage of air or even mechanical collapse due to atmospheric pressure. The British Thomson-Houston Company only advocates the use of a pure exhaust steam turbine when it is connected to a single engine, and the two operate together as a single unit, and are controlled only by the engine governor. The great advantage of the mixed pressure turbine in other cases is that, not only does it make use of the exhaust steam, as in the case of a pure exhaust steam turbine, but it will also carry all or any part of its load with high-pressure steam taken directly from the boiler.

(To be continued.)

A NEW THEORY OF PLATE SPRINGS.*

By David Landau and Percy H. Parr.

Paper I.

Probably the first paper of historial importance in connection with the study of the strength of materials which influenced the work of the elasticians of the seventeenth and eighteenth centuries was that published by the famous Italian astronomer and physicist, Galileo Galilei, in 1638.

Galileo's paper was the forerunner of several others which were published, dealing with the strength and rupture of beams; it was Galileo who found that a "solid of equal resistance" must have a parabola for its generating curve.

English investigators speculated much upon the nature of bodies which were elastic, frequently quoting the Scriptures as authority for their deductions and reasonings. A curious example of these "speculations" into the cause of elasticity may be found in a paper by Sir William Petty on "The Discourse made before the Royal Society concerning the use of Duplicate Proportions; together with a New Hypothesis of Springing or Elastic Bodies" (London. 1674.) The author describes a complicated system of atoms, which he endows with polar properties, and even sexual characteristics, in order to explain his theory.

* Communicated by the Authors to the "Journal of the Franklin Institute."

Modern conceptions of elasticity no doubt began with Robert Hooke. In a work published in London in 1678 he informs us that 18 years previously he had first formed his theory of springs. He purposely refrained from publishing his theory, as he was anxious to obtain a patent for a particular application of it. His anagram, which concealed his theory, is too well known for repetition here; it need only be remrked that the clarity and generality of his statements lead us to say that Hooke is well deserving of the place he occupies in the history of elasticians of the first rank.

Chronologically, the next elastician of note was Mariotte; he was the first to recognise that in a beam subject to flexure one-half of the fibres are compressed, while the other half are extended. The term "fibre stress" must have had its origin about this time. Mariotte's work was published in Paris during 1686, and shortly thereafter G. W. Leibnitz stated that the stresses in the fibres are proportional to their extensions, thus applying Hooke's Law to single fibres.

Varignon, whose work was published in Paris during 1702, and Parent (Paris, 1710) studied the form of solids of uniform resistance; James Bernouilli's work must be mentioned in passing.

Sir Isaac Newton's work in the cause of elastic studies is, so far as concerns us, of only passing interest; his brilliant efforts in the domain of mathematics, on the other hand, influenced every field of scientific investigation, and ours none the less. The greatest investigator of the Newtonian period, and probably Newton's equal, was the famous mathematician Euler. Lagrange, in 1771, published a paper of some interest dealing with springs.

A paper by James Jurin, "On the Action of Springs," in the "Philosophical Transactions" for 1744, deals with the application of Hooke's Law to a special case.

Coulomb's published work in 1784 on "Torsion Springs" referred to metallic wires, and his first paper, published in 1777, dealing with the torsion effects on hairs and silk fibres, while not immediately related to our present paper, had a general stimulating effect on investigations of the general theory of elasticity.

Thomas Young, the English physicist, gave, in 1807, his first exposition of what we now call the "modulus of elasticity," or "E." Young was not a mathematician, and his statements often lacked the clarity of exposition and generality which we get from mathematicians.

The modern theory of elasticity may be said to begin with Navier (1785-1836), who, in 1820, analysed the flexure of rods and solved the problems relating to the reaction of flexible bodies for which the elementary statics afford no solution.

Poisson began those portions of his elastic researches which concern us in 1814; and it has been said of him that there was hardly a problem in the domain of the elastic theory which he did not in some way or another investigate; his nearest equal was Cauchy.

Mechanical engineering began to demand much from elasticians about 1840, and we find thus, as a result, the work of Poncelet on the "Theory of Resilience" which answered one of the demands. Lame and Clapeyron, studying the strength of iron used in bridges, found, as a result of their practical studies, a most beautiful analysis in the field of elastic theory; their work greatly influenced all the later investigators. During the period 1840-50 appeared the works of Seebeck, Morin, Masson, Smith, and Newman, all of which are of sufficient importance to be mentioned here.

The greatest investigator, from our point of view, who combined practical knowledge with analytic ability of the highest order, and applied both to the study of the leaf spring, was, without doubt, E. Philips. Even at this late day, however, little is known of his work—even in his own country—France. An engineer by profession, yet an analyst of the most brilliant type, he alone attacked the problem of the plate spring in a truly scientific manner, and solved some of the most important problems requiring mathematical investigation. His researches were published in 1852, and almost every work on applied mechanics published since, which deals with the plate spring, has been based, to a greater or less extent, on his researches.

His paper, entitled "Memoire sur les Ressorts en Acier Employés dans la Material des Chemins de Fer," appeared in the "Annales des Mines," Tome I., 1852, pp. 195-336.

The Academy of France appointed a committee, consisting of MM. Poncelet, Seguier, and Combes, to investigate Philips's work; they reported concerning this work as follows: "Le Travail de M. Philips sera fort utile aux ingénieurs et aux constructeurs, qu'y trouveront des régles rationelles et d'un application facile pour les établissements des ressorts capables des satisfaire, aux la moindre dispénse de matière, à des conditions données de flexibilities et de résistance."

While there is no question as to the excellency of the work of Philips and its marvellous analysis of such a difficult problem, yet we do not quite agree with the committee's report. That the essence of the work of M. Philips may be "easily applied" to practical problems is a statement somewhat overdrawn: we confess, after a very careful and serious study of his memoir, that the applications of his equations are, in nearly all cases, most difficult, and, with the exception of a particular case, his expressions are outside of the range of practical utility. This does not vitiate, however, the scientific importance of this work. Philips published other papers, but the one mentioned is, for the present, the most important.

In 1880 a graphic application of Philips's work was made by Lèvy Lambert; the graphs given cover only special cases.

(To be continued.)

THE UNAFLOW STEAM ENGINE.

By D. H. Yates.

(*Continued from page 57.*)

Clearance Volumes and Surfaces.

Fig. 1 illustrates a type of counterflow cylinder largely adopted by British and Continental makers, and consists of a plain cylinder barrel with a separate head or valve box at each end. Each valve box contains a steam and exhaust valve, the steam valve being in the upper portion and the exhaust valve in the lower portion of the valve box.

Fig. 2 illustrates a Unaflow cylinder, which consists of a cylinder barrel having exhaust ports in the centre, with a separate head at each end, each head containing a steam valve, but no exhaust valve, the exhaust ports in the centre of the cylinder barrel doing away with the necessity of having any exhaust valves and gear. The advantages derived from this arrangement of exhaust are numerous, the chief of these being:—

1. Simplicity of construction.
2. No exhaust valves or gear to get out of order.
3. Reduction of cost in production and upkeep.
4. Higher mechanical efficiency of engine, due to reduced friction load brought about by absence of exhaust valves and gear.
5. Large reduction in clearance spaces and surfaces.

This latter is perhaps the most important of these items, and that the clearance is considerably less in a Unaflow than in a counterflow cylinder may be seen by a comparison of Figs. 1 and 2. In addition to there being no exhaust valve clearance, which usually makes up a great portion of the total clearance in a counterflow cylinder, it will be seen that the space taken up on the cylinder side by the steam valve and port is considerably less in Fig. 2 than in Fig. 1. This is due to the fact that owing to the short length of steam admission, which is from 8 per cent to 12 per cent of the stroke for varying admission pressures under normal full load working conditions, a far greater steam admission velocity is permissible than would be the case if the cut-off were fixed at, say, 25 per cent of the stroke, as is often the case in the high-pressure cylinder of a compound counterflow engine. This then allows of the adoption of less steam valves and smaller valve lifts, with the results previously stated.

A comparison of the cylinder volumes of a well-designed Unaflow condensing engine and an equally well-designed counterflow condensing engine is here given.

Type of Engine.	Clearance Volume in % of Stroke Volume.	
	H.P. Cylinder.	L.P. Cylinder.
Unaflow Condensing	1½% to 2½%.	....
Counterflow Condensing...	5% to 6%.	6% to 10%.

The comparative clearance surfaces are approximately as follows:—

Type of Engine.	Clearance Surface, taking one cylinder cover face + one piston face, both flat, as 100 %.	
	H.P. Cylinder,	L.P. Cylinder.
Unaflow Condensing	133% average.	....
Counterflow Condensing ..	210% to 250%.	190% to 260%.

It will be seen that both in the case of clearance volume and clearance surface the Unaflow engine has a decided advantage over the counterflow engine. The figures given will, of course, vary with different makers, but they may be taken as being a fairly good average.

Effects of Clearance Volumes and Surfaces.

The reduction of clearance volumes and surfaces has a very marked effect on the steam consumption of an engine. If we deal first with the clearance volume, we find by a comparison of the indicator diagrams that, other things being equal, an engine with a large clearance volume requires more steam per indicated horse-power than does one with a smaller clearance volume, due to the fact that less advantage can be taken of the expansion and compression of the steam.

Dealing next with the clearance surfaces, we find that the live steam on entering either of the cylinders of a compound engine, immediately comes in contact with these clearance surfaces, and these being comparatively large, there will necessarily be more cylinder condensation, even if there happened to be no disadvantage due to the cooling of the clearance surfaces owing to the counterflow action of the steam as previously explained.

We thus see that increase of clearance volume and clearance surface means increase in steam consumption, and by reducing these two items we reduce steam consumption. In this matter the Unaflow engine has a decided advantage over the counterflow engine. It will thus be seen that the general design of a Unaflow cylinder tends to minimise condensation in the cylinder, and enables a large range of expansion to be carried out in one cylinder. Having now explained the main principles of the theory of the Unaflow engine, and compared them with those of the counterflow engine, we will next consider its design in detail, and the reasons for such design, commencing with the cylinder.

(To be continued.)

COAL SHORTAGE AND ECONOMY.

The above is the serious question addressed to steam users by the Government authorities. Four hundred experts were appointed by the Coal Controller to advise steam users to eliminate waste. Some steam users may have been under the pleasing delusion that they knew all that was to be known of practical importance on the subject without calling in experts. But in numbers there is wisdom—so says the legend. The experts declare over 100,000 tons of coal may be saved if steam users economise.

The bewildered steam user wades through statistics, and having carefully cross-examined the gentleman from his boiler-house, who is addicted to the habit of constantly wiping his fingers with a piece of dirty cotton waste, fails to grasp thoroughly the suggested economy of the experts. He may have read an article in a trade paper giving nine "efficiencies," ranging from 80 per cent to 50 per cent.

The steam user may own a saw mill, or brick yard, or be spinning cotton, or running a confectionery works; and the mysteries of the boiler-house

he never has had time to explore. So long as Sam in charge turned out sufficient steam to run the machinery, the genial steam user never bothered his busy brain about nine or one "efficiencies." Never dreamt such things existed, and now that Sam is in France, and his place occupied by an elderly general labourer or house painter, the mysteries of "efficiencies" and percentages become perplexing in the extreme. "She must have as much coal as she wants," says the dogged handyman.

But the question of coal economy is an immediate war measure; and, eliminating experts and percentages, the question for steam users, large and small, is—how to economise?

First, are your boilers covered with incrustation, which keeps the plates hot and the water cool? If so, you are burning at least 33⅓ per cent more fuel than necessary. You don't save fuel by chipping your boiler once a month or six weeks. An eighth of an inch of scale on a boiler means at least 33⅓ per cent increase in consumption of fuel. In addition to waste of fuel, you are ruining your boilers by overheating in consequence of the presence of scale.

To obviate scale, use a preparation like "Dejecoline" Boiler Scale Removing Fluid. It is prepared to counteract the scale-forming ingredients in the boiler feed water, after an analysis of same. "Dejecoline" has been used for this purpose with great success in all His Majesty's dockyards for over 20 years, and no better testimonial of its efficiency could be submitted. It is also used by leading engineering firms at home and abroad from London to Ceylon and West Indies.

You can save fuel in your boiler-house by using "Dejecoline." Again, on the question of fuel economy, are your boilers and steam pipes properly protected against radiation of heat by non-conducting material? If not, and there are any defects in the lagging, you can procure an excellent asbestos non-conducting boiler covering composition ready mixed in casks, from the British Boiler Fluid and Engineers Stores Ltd., Bermondsey, at a reasonable price. The material is quite ready for application and is put on while steam is up at convenient spare time.

This firm also supply their well-known Excelsior Belt Dressing, which prevents straps from slipping and increases the driving power and efficiency of all kinds of belts, except rubber.

TYPES OF CONCRETE VESSELS URGENTLY NEEDED.

So far as the Department of Merchant Shipbuilding is concerned, the most urgent need at the moment in the way of concrete vessels is for sea-going barges of large capacity. Vessels of these types are being built in all the Admiralty Auxiliary Shipyards, and the results of the work carried on during the past six months are beginning to show in the launches now taking place in different parts of the country. Other types of vessels are, however, very much needed, such as self-propelled ocean-going steamers of the class that has proved so successful in the United States, and motor boats and ships, such as have been built in considerable numbers on the Continent, in America, and in outlying parts of the world. Several of the firms of engineers and constructors who are interested in concrete shipbuilding in this country are quite prepared to commence the construction of vessels of all these types, and as a matter of fact some half-dozen steamships are already on the stocks at Barrow. The trouble seems to be that nothing can be done towards the further development of the new branch of the industry without Government facilities for the supply of steel and other materials. It is quite reasonable that the pressing needs of the Admiralty for barges should receive exclusive attention in the controlled yards, but there is no reason why the efforts of those in such establishments should not be supplemented by work in private shipyards. If the authorities would favour this view and give adequate facilities, it is certain that the available tonnage might be very greatly increased in the course of a few months, and the concrete shipbuilders of this country would no longer be obliged to watch the progress of their competitors elsewhere, while their own hands are tied by Government restrictions. As the steel required is little more than half the amount needed for steel ships, and as the labour, both skilled and unskilled, is drawn from sources which afford no help to steel shipbuilding, there is no real obstacle to the removal of the existing obstacle to the development of concrete shipbuilding on the lines adopted on the Continent and in the United States.

ELECTRICITY SUPPLY.

The Minister of Munitions in exercise of the powers conferred upon him by Regulation 11A of the Defence of the Realm Regulations and all other powers thereunto enabling him hereby orders as follows:—

1. No person shall on or after the date hereof except under and in accordance with the terms of a permit issued under the authority of the Minister of Munitions:

(a) Connect or cause to be connected to any source or means of supply of electricity any place or any building, premises or plant or any part thereof not so connected at the date hereof, or

(b) Supply or cause to be supplied any electricity to any place or any building, premises or plant or any part thereof not supplied with electricity at the date hereof, or

(c) Use or cause to be used any electricity in or at any such place, building or premises or for the purpose of any such plant as hereinbefore mentioned.

Provided that in any case coming within the scope of the Household Fuel and Lighting Order, 1918, or the Household Fuel and Lighting (Scotland) Order, 1918, as defined by Clause 1 of these Orders respectively, where the previous assent of the Local Fuel Overseer is required and has been duly obtained to any fitting, equipment or supply under Clause 99 of the first mentioned Order or Clause 77 of the secondly mentioned Order, no permit hereunder shall be required for such fitting, equipment or supply or the use of such supply.

2. All applications with reference to this Order should be addressed to the Director of Electric Power Supply, Ministry of Munitions, 8, Northumberland Avenue, London, W.C. 2.

3. This Order may be cited as The Electricity (Restriction of New Supply) Order, 1918.

Note.—The permission required by the Order is in addition to and not in lieu of the usual Priority Certificates and permit reference number.

DETERMINATION OF TOTAL CARBON IN FUELS.

In a recent article in the *Revue Metallurgique*, Messieurs E. Damour and M. de la Marmière point out that in considering the heat economy of a fuel the total carbon content has an importance not generally recognised. Few laboratories are capable of estimating this content rapidly, and in general a commercial analysis including ash, fixed carbon, volatile matter, and sometimes calorific power is considered sufficient. In making a balance sheet of heat production and consumption in an industrial furnace, it is impossible to calculate the amount of heat lost outside the furnace without using a term of comparison common to the fuel and to the gaseous waste products of combustion. From the content of total carbon in the fuel it is possible to calculate the volume or weight of gaseous products of combustion. The apparatus used by the authors for the determination of total carbon is a combination of the Mahler-Goutal bomb (fitted with an additional outlet) with the usual absorption tubes generally associated with the combustion furnace in organic analysis. 0·5 grm. of the fuel, contained in a silica capsule, is introduced into the apparatus. After the explosion, and on opening the connection to the tared absorption vessels, the gases circulate through sulphuric acid, soda-lime, potash, and pumice stone moistened with sulphuric acid. A large Maquenne tube charged with 50 c.c. of de Nolly's solution (alkaline solution containing about 4 grms. of soda per litre) indicates any loss of carbon dioxide due to failure to regulate the speed of gas flow. In this way it is possible to determine in $1\frac{1}{2}$ hours the total carbon of the fuel. Tests have shown that the losses due to the residue from combustion and formation of carbon monoxide or of hydrocarbons are negligible. A correction is made for the carbon dioxide remaining in the bomb. To ensure complete combustion and to reduce the error possible from the amount of space in the bomb, the authors recommend a smaller bomb of 250 c.c. capacity and adapted for a pressure of 25 atmospheres. From the results of tests conducted as above, the authors give elaborate calculations leading to a thermal balance sheet of a battery of boilers and of an open-hearth furnace respectively.

LLOYD'S REGISTER AND CONCRETE SHIPS.

Although no rules have been formulated by Lloyd's Register of Shipping for reinforced concrete ships, the practice of the Society is to require that the quality of the steel used as reinforcement shall be the same as that given in Section 3 of their rules for steel ships, and that the cement shall comply with the requirements of a recognised standard specification. So far as concerns the preparation of the concrete, the proportions of the constituents are left to individual constructors, and with regard to the design of the reinforcement it is considered that no account is to be taken of the tensile strength of the concrete. In all other respects, designs are considered on their merits and the Society are ready to assist in the matter of construction so far as lies in their province, and any plans put forward will receive their careful consideration.

Publications.

Messrs. B. and S. Massey Ltd., of Openshaw, Manchester, in their catalogue, No. 2390 H., describe their steam-hammers for "cogging" and "tilting" steel bars, the former being a process by which cast-steel ingots are reduced to a suitable size for "tilting" or rolling, and the latter a process for the drawing out of the steel bars to the desired section, at the same time producing a highly-finished surface. These hammers are made in various standard sizes from $1\frac{1}{2}$ cwt. to five tons; those up to 7 cwt. being sometimes used for plating shovels, spades, and hoes, etc., and the smaller sizes (from $1\frac{1}{2}$ cwt. to 2 cwt.) for drawing out the prongs of forks for agricultural purposes. Self-acting valve gear is fitted to all sizes up to 40 cwt., the "Arch" type having the valve motions directly connected to the tup by means of a lever; the overhanging type having the valve operated by means of a cam. On both machines the travel of the valve can be adjusted by a lever, thus altering the length of the stroke. On the sizes of 40 cwt. and over, hand-operated valve gear is fitted, the "Massey patent" hand-worked expansion valve gear being fitted at extra cost, if so desired. By this valve gear it is claimed that a great reduction in steam consumption and improvement in control is obtained. Much useful information regarding the care and maintenance of these hammers is given, and a table is compiled showing the most suitable plant for a desired purpose. The firm are also makers of steam and power hammers for sundry purposes, steam and friction stamps, compressed air hammers, and band-saws. Catalogues dealing with these specialities in detail are to be obtained on request.

The efficient drying and impregnating with a suitable insulating varnish is absolutely essential to the sound construction and life of electrical apparatus. Plant for this process is described in a booklet (No. 104) published by the **J. P. Devine Company,** Buffalo, N.Y. Briefly, the apparatus consists of a vacuum drying and impregnating chamber (either steam jacketed, heated with a steam coil, or hot-oil circulating system), coupled to a liquor tank arranged with a similar heating device, the connecting pipe, valve, etc., being steam jacketed in order to maintain the temperature of the liquid. The articles under treatment are thoroughly dried under vacuum, the impregnating liquid being then drawn into the chamber. Air is admitted, and by a special arrangement the action of the vacuum pump is reversed, the air being compressed considerably, which greatly assists the process of impregnation. It is stated that the floor space is considerably less, the time occupied being half that of the old baking process, the result being a perfect impregnation. This apparatus is not confined to the electrical industry alone; leather, asbestos, cotton and similar materials may be treated with various compounds; wood dyed to represent ebony, mahogany, etc.; pipe-bowls stained; pencils treated with cedar stain, etc. Fruit may also be candied by impregnating with a sugar solution. A special plant is made for the treatment of cloths, fabrics and cords used in connection with the rubber industry, the solvents used in the compounds being recovered. These are only a few instances in which this plant is used. It is stated that there are over 3,000 in successful operation, and those having impregnation problems should communicate with this firm. The British agents are Messrs. James Livingston Ltd., Sardinia House, Kingsway, London, W.C.

The Standard Plating and "Kupron" Works Ltd., 62-68, Rosebery Avenue, Clerkenwell, London, have issued a brochure with reference to the electro-deposition of copper. This is known as the "Kupron" process, and it is claimed that practically any desired thickness of copper may be deposited on almost any material, particularly plaster and stone, the former being treated to a process of impregnation which hardens and preserves it, and at the same time causes the deposited metal to firmly adhere to the surface. This is especially suitable for interior decorations. Name plates, and all kinds of door furniture may be treated in the same way, and are stated to be of higher finish and superior to those of cast bronze or brass. Chasing is not required, and the exact character of the model is maintained. The deposited metal is said to be of high density, takes a fine finish, and can be chemically treated to obtain those colourings which suitably harmonise with the surroundings. Ironwork is now "Kupronised" for outside work, and, except for the initial cost, is stated to be far superior to painting. The fact that difficult sections of tubing are made by this process from models (the flanges being inserted beforehand), producing a perfectly seamless

article, should be of considerable interest to engineers. Hydraulic rams, shafting, steel tubing, etc., are coated with any desired thickness up to a quarter-inch. An abstract of a paper written by Mr. G. L. Roslyn, the managing director of the company, on electro-metallurgy, and read before the Belfast Association of Engineers, is published, containing much interesting information on this subject.

To gas, water and steam engineers, and all those engaged on schemes where pipe work is greatly in evidence, a little booklet issued by the **Stanton Iron Works Ltd.,** of Stanton-by-Dale, near Nottingham, should be of special interest. It contains the thickness, lengths, and weights of cast-iron socket and spigot pipes from 1½in. to 48 in., bends, collars, tees, crosses, branches, etc., connected with the same. Cast-iron flanged pipes are also made, and dimensions and weights of all these are similarly given. The firm also are manufacturers of cast-iron tanks for various purposes, manhole covers, tar-wells, strainers, surface boxes, etc. Special plant has been laid down for the construction of segment plates for tube railways, colliery tubbings, and curbs. The booklet is pocket size, well illustrated and tastefully bound, and contains a considerable amount of engineering memoranda and tables. The booklet reflects great credit on those responsible for its publication.

To those interested in motor vehicles, **Messrs. Brown Bros. Ltd.,** 20-34, Great Eastern Street, London, have published a pamphlet describing the "Duco" spring gaiter. This is a flexible cover enveloping the springs and fitted with a lubricator, the grease being injected by means of a pump. The spring leaves are, it is claimed, therefore not only protected from mud, dust, and water, but also obtain a plentiful supply of lubricant, consequently the car rides more comfortably on the road. The wear and tear of the springs is also considerably reduced. The "Duco" valve-stem lubricator is also illustrated and described. It is stated to have the effect of eliminating valve sticking, etc., and reducing friction in that direction to a minimum.

Obituary.

MR. EDWARD BENNIS.

It is with extreme regret we have to record the death of Mr. Edward Bennis, head of the well-known firm of Edward Bennis and Co. Ltd., of Bolton and London, makers of mechanical stokers, coal and coke handling plant, and other appliances dealing with the general conveyance of coal to and ashes from steam generators, furnaces, and the like.

Mr. Bennis was born in Limerick in 1838, and was educated at the Quaker College of Newtown, in Waterford. On leaving the college, he was apprenticed to Mr. Thomas Chandler, of Balls Mills, County Waterford, subsequently entering the service of Mr. Peter Moore Fisher, of Pilton, County Cork. He afterwards started in business on his own account, and it says much for his industry and application that within a few years he had acquired a competency, which enabled him to retire from business and reside, first in Paris, and afterwards in London.

Some years later, entering once more into business, he began to take an active interest in the mechanical firing of boilers—a subject of unknown potentialities.

Previous to the year 1873, the firing of boilers by mechanical means was almost unknown, though there were even then two types of machine-stokers brought forward and used on a small scale; but the appliances were so imperfect that they were of little actual benefit to steam users. It was at this stage in the history of the subject that Mr. Bennis joined Mr. Dillwyn Smith, of Philadelphia. Works were started in Liverpool, but Mr. Bennis soon came to the conclusion that the system which provided only for throwing the fuel on the fire was incomplete, and that better results were possible if an efficient furnace could be devised by which the fire-bars would be automatically freed from clinkers whilst the machine distributed the fuel over the fire.

After laborious and lengthy experiments, Mr. Bennis succeeded in inventing a self-cleaning furnace, which answered the requirements he had set himself to meet. These efforts were now rewarded with well-deserved success. A great increase in evaporation was effected in boilers fitted with his apparatus, while the smoke was lessened so as to do away with nuisance, and a considerable economy was effected, which soon paid for the machinery. As might be expected, a trade was created when these advantages were recognised, as was soon the case.

Mr. Bennis continued to improve his machine, and ultimately established his works in Bolton, which was a better centre than Liverpool for his operations. A new principle of machine-firing was later introduced, in which the coal was spread over the fire, not in a continual rain, as in the older machines, but by a striker which distributed it intermittently, striking the fuel a blow, and so varying the strength of this blow that only a part of the fire was covered at any one time, allowing a short period for the part of the fire on which coal was distributed to become incandescent. The newer principle effected a complete revolution in machine-firing, and took rank as a leading engineering industry.

Others soon followed the lead given by Mr. Bennis, and in a very short time the subject of machine-firing had aroused such attention that a competition of mechanical stoker makers was held at the Manchester Sanitary Exhibition in 1882. A medal was issued for merit on the points of smoke abatement, power and efficiency, and this was won by Mr. Bennis.

Later, at the Yorkshire Jubilee Exhibition, a gold medal was offered for the best system of machine-firing, and this again was won by Mr. Bennis. At these trials very onerous terms were imposed, the conditions requiring competitors to run the exhibition from morn till night without touching the fires, and with an absolutely smokeless chimney.

More recently still, a newer system was introduced by Mr. Bennis, in conjunction with his son, in which all the advantages of forced draught, machine-firing, induced draught, and self-cleaning furnace have been concentrated in one invention. It is said that by means of this the rating of a boiler may be nearly doubled, while maintaining a very high economical efficiency and a smokeless chimney. We need hardly say that it is difficult to overrate the importance of an invention which enables a user to increase the steaming power of his plant to such an extent, and which also provides the means of keeping the steam pressure steady under very great variations in the load, such as occur in dyeworks, steel works, and electric light generating stations.

It is evident that when a considerable number of boilers are fitted with machine-firing apparatus, a great advance is made if the fuel can be fed to the hoppers of the machine-firing apparatus by mechanical means, and the ashes and clinker removed from the front of the boilers by similar means. To effect this an adaptation of apparatus already used by collieries was first tried, but improvements quickly suggested themselves, and in a short time the patents were taken out which kept the Bolton works busy producing fuel-conveying plant. The latter includes automatic weighing machinery, which weighs the fuel in transit into the works, tips it into the conveyors, and registers the weight delivered in the day.

The works at Bolton being found too small in 1904, a site for a new factory was obtained at Little Hulton, near Bolton, provided with railway siding accommodation. Two acres of land were first covered with up-to-date buildings, provided with electric cranes and every appliance to get the utmost output. Since then the buildings and plant have been extended year after year to meet the continued growth of business. All types of machine-stokers are now built, including chain grates for water-tube boilers and every description of coal-handling device—coal bunkers, pneumatic ash-handling plant, conveyors for coal, cement and like products.

The firm have now branch establishments or concessionaires in most of the countries of the world, and their machines are being manufactured in many of the European countries, and even in far Japan.

Of late years Mr. Bennis and his son have devoted much attention to the mechanical-firing of boilers on board ship. Some early experiments in this direction met with considerable success, but improvements since made have shown that this branch of the subject is as fully open to exploitation as the automatic firing of ordinary boilers. Its development is, however, for the time being, held in suspense in consequence of the war.

The firm was declared a controlled establishment very early in the war, since when the whole of its resources has been devoted to the manufacture of equipment for increasing the output of munitions, and labour-saving appliances for munition factories.

The history of Mr. Bennis is one of which any man might well look back with pride. It is at once a record of high endeavour, of work well done, and an inspiration to the generation following him.

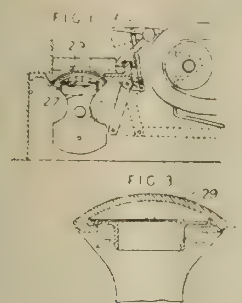
Patent Applications.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

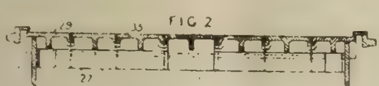
ABSTRACTS OF SPECIFICATIONS.

FURNACES.

117,594.—BABCOCK & WILCOX, 30, Farringdon Street, A. E. PARKER, 56, Lyncroft Gardens, West Hampstead, and C. S. DAVY, 162, Rosendale Road, Dulwich, all in London, and D. G. MEIKLEREID, 93, Burnt Ash Hill, Lee, Kent.—June 19th, 1917.—An ash-discharger or door arranged at the rear of a chain grate as



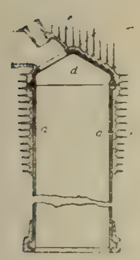
described in Specification 5362/03 is constructed of a plurality of sectional members 29 mounted on a frame 27, to which they may be secured by screws, as shown in Fig. 1, or by inwardly-projecting lips as shown in Fig. 3. In the latter case, the sections are inserted at the centre, where the frame is gapped to allow the



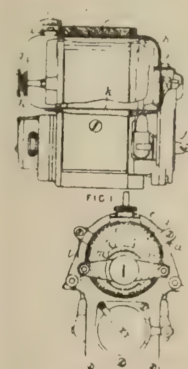
passage of the lips, and slid along to either end, and the central section is secured by bolts. The sections may be formed with offset projections 35 to engage beneath the adjacent sections as shown in Fig. 2.

INTERNAL-COMBUSTION ENGINES.

117,596.—S. S. GUY, Woodview, Finchfield, Wolverhampton.—May 2nd, 1918.—The cylinder barrel *a* and head *d* are separate and each has cast on it cooling-fins *c*, *e* of a lighter metal such as aluminium.



Patent 117,596.



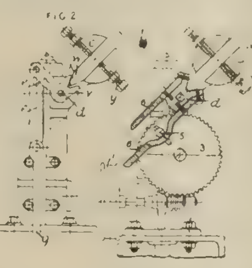
Patent 117,639

DYNAMO-ELECTRIC MACHINES.

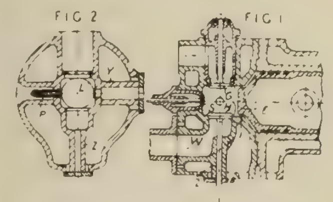
117,639.—H. LUCAS and C. L. BREEDEN, Lucas Ltd., Great King Street, Birmingham.—April 23rd, 1917.—A lighting dynamo *e* is mounted in the magnet arch of an ignition magneto so as to be readily detachable without interfering with the magneto. A boss *f* on the dynamo *e* enters an aperture in the end cover *b*; a detachable cover *g* at the other end is secured to the magneto cover *a* by a clamping bar *h* or by screws. The dynamo armature *m* is rotated from the magneto shaft *j* by chain or toothed gearing. A brass or other non-magnetic tube *k* may be secured between the end covers to receive the dynamo; the permanent magnet may be bulged as shown at *l* to form a wider arch than usual. The dynamo may have an eccentrically mounted armature *m* and a singe wound pole *n*.

RAISING AND FORCING LIQUIDS, ETC.

117,643.—S. H. ADAMS, White House, Fulford, York.—May 16th, 1917.— Relates to apparatus in which the valves controlling admission and exhaust of compressed air to and from the forcing-chamber are operated by a snap-action employing a rocking-weight, and consists in providing the weight, which is loosely mounted on the valve-actuating shaft, with an adjustable wedge shaped member whereby the times of operation may be varied. In the arrangement shown in Fig. 2, two quadrant arms (not shown) upon a spindle *d* operate a vertical valve-rod (not shown), the spindle being reciprocated by a float through the medium of links *g*, *f* with a slotted lost-motion connection to an arm *e* upon the spindle. The snap-action of the spindle isensured by a weight *c* carried by an arm mounted loosely thereon and having a wedge-member *w*, adjustable in position by screws *y*, for contacting at the desired angles with cheeks *v* rigid with the spindle. Fig. 5 shows a power-driven arrangement, wherein a belt rotates a pulley 1 and thus a disc-crank 3, of which the adjustable pin 5 co-operates with jaws 6, 61 rigidly mounted upon a throw-over spindle provided as before with a weight and an adjustable wedge-member.



Patent 117,643.



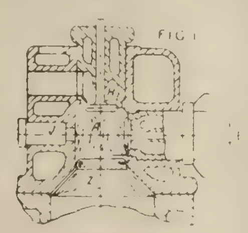
Patent 117,670.

INTERNAL-COMBUSTION ENGINES.

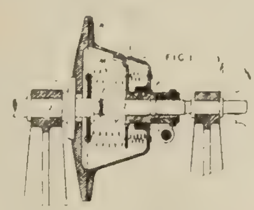
117,670.—SIR K. I. CROSSLEY and W. LE P. WEBB, Crossley Bros. Ltd., Openshaw, Manchester.—July 25th, 1917.—A four-stroke-cycle engine has a water-jacketed combustion chamber adapted to enable the engine to be used either as a high-compression oil engine in which the heat of compression ignites the charge, or as a low-compression gas, etc., engine. The combustion chamber is shaped as shown in Figs. 1 and 2, the end wall being semi-circular in plan. A circular neck L is adapted to receive an extension E on the piston employed when the engine is used with oil fuel. The air, etc., inlet valve G is arranged at the top of the combustion chamber and the exhaust valve H at the bottom, the distance between these two valves being about half the diameter of the cylinder. A compressed-air starting-valve S is arranged at the end of the combustion chamber. When the engine is used with oil fuel, an electric or hot-bulb ignition-device P may be arranged opposite the oil-inlet device to facilitate starting the engine; or two oil-inlet devices may be arranged opposite one another. When the engine is used with gas fuel, two sparking-plugs may be employed. In order to prevent fracture of the casting forming the water-jacketed combustion chamber due to changes of temperature, certain of the parts (such as the exhaust branch W and the bosses Y, Z) are integral with the inner wall of the casting but are not rigidly connected to the outer wall. Specification 29337/12 is referred to.

INTERNAL-COMBUSTION ENGINES.

117,671.—SIR K. I. CROSSLEY and W. LE P. WEBB, Crossley Bros. Ltd., Openshaw, Manchester.—July 25th, 1917.—The combustion chamber A is of such a volume that liquid fuel is ignited as it enters by the heat of compression of the compressed air charge, but by reducing the length of the piston to the dotted line Z the engine will work as a gas engine. The cylinder is vertical, the exhaust valve H being in its end and the admission valve G for air or combustible mixture in the side of the combustion chamber. One or two oil nozzles J, a sparking-plug, and a compressed-air-starting valve also are arranged in the walls of the chamber. Specification 29337/12 is referred to.



Patent 117,671.



Patent 117,673.

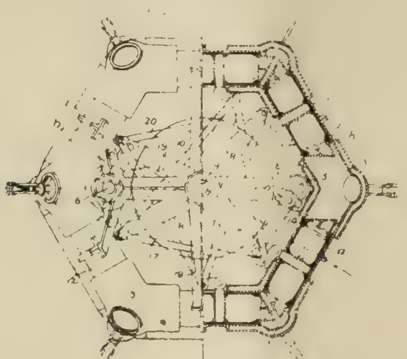
CLUTCHES.

117,673.—C. TER COCK, Eastside Road, Golder's Green, London.—July 5th, 1917.—In friction clutches of the kind in which main clutch springs act during part of the period of engagement and disengagement through weaker auxiliary springs, the main springs are tension springs, while the auxiliary springs may act either in tension or compression. Fig. 1 shows the use of auxiliary compression springs. The main tension springs M are secured to the operating-collar E and to a disc E1 loose on the driving-shaft 2. The auxiliary springs C connect the collar E and the driven clutch-part R. During disengagement, the collar E removes pressure from surfaces X on lugs secured to the part R and subsequently relaxes the tension on the springs C until the collar engages a surface Y on the part R and positively disengages the clutch. During engagement, the full pressure is not applied to the clutch until the collar E engages the surfaces

X. The free movement of the collar E may be provided for by the use of pins and slots. When auxiliary compression springs are used, the two sets of springs may be arranged around the circumference of a circle.

INTERNAL-COMBUSTION ENGINES.

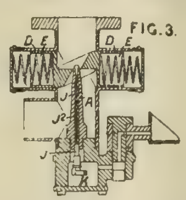
117,684.—A. H. WILLIAMS, 2, Waterloo Road, Chester.—July 27th, 1917.—Cylinders 1, 2 are arranged in polygonal formation around a central driving-shaft 9 and contain double-acting pistons which are acted upon in pairs by explosions occurring in chambers located at the angles of the polygon. Fig. 1 shows a four-stroke-cycle engine in which the pistons of alternate cylinders a are connected to oscillating arms 8 one of which is connected to a



crank-shaft 5 by a rod 14, the shaft carrying a pinion 16 which gears with a wheel 17 on the main shaft. The pistons of the cylinders b are similarly connected through arms 19 and a rod 21 to a crank-shaft 6 carrying a pinion which gears with the wheel 17. Each set of arms 8, 19 is braced by rods 10, 20 respectively. Inlet and exhaust valves, actuated from the main shaft through two-to-one gearing, are mounted in the combustion chambers 3 which are each common to two pistons. Slots 23, through which the gudgeons pass, may be uncovered by the pistons and thus serve as exhaust ports. The engine may comprise one or more cylinder units.

INTERNAL-COMBUSTION ENGINES.

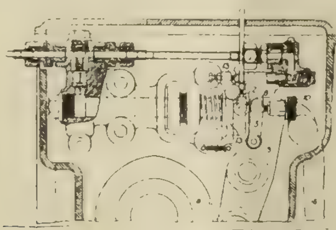
117,692.—H. J. STORY, 20, Alexander Street, Sherwood Rise, and A. H. PUGSLEY, Woodborough Road, Mapperley, both in Nottingham.—Aug. 3rd, 1917.—The area of the passage around the fuel nozzle A of a spray carburettor is varied by the forked inner extremities of two piston members E sliding in lateral casings D. The members are actuated, so as to move away from the nozzle in opposite directions, by a cam engaging rollers thereon and



are returned by springs. The cam carries on its spindle a second cam, adjustable angularly and radially, which actuates a valve J with coned head J2 in the nozzle, through the medium of a vertical rod and two levers, one of which, K, is shown. The members E may be actuated by links. According to the Provisional Specification, the passage around the nozzle in the closed position of the valve members may be conoidal in shape.

RECIPROCATING PUMPS.

117,728.—W. T. BELL and C. F. PITT, Globe Works, Lincoln.—Sept. 22nd, 1917.—In fuel pumps for internal-combustion engines, the delivery is controlled by opening a valve 1 of a return circuit in the delivery pipe for a variable period during the delivery stroke of the pump. The plunger is actuated by a cam 4 and

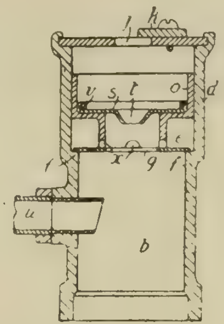


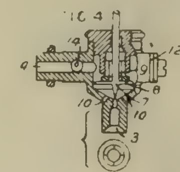
lever 3, on which is pivoted a plate 5 adjustable on the lever by means of a screw 8 and nut 10. During the delivery stroke, the plate 5 opens the valve 1 through a roller 12 and lever 13, the time of opening depending on the position of the roller 12, which is controlled by the governor. The pump may be actuated by a hand-lever 16.

INTERNAL-COMBUSTION ENGINES.

117,726.—J. A. TORRENS, Moylena, Muckamore, Co. Antrim.—Sept. 18th, 1917.—Means for admitting air and, at times, water to the induction pipe comprises a casing b, a shoulder f on which supports a diaphragm e which has a restricted aperture g and supports a suction-actuated valve o. The valve works in an enlargement d of the casing b, carries a plate s with flanged aperture t and secured by a split ring v, and has holes x in its lower edge to ensure a gradual opening. Air is admitted to the chamber d

FIG 1

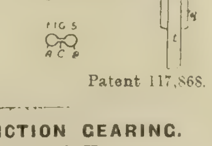




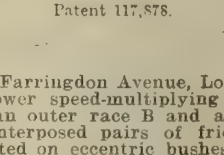
through ports just above the diaphragm e and through a port j controlled by a shutter k. Combustible mixture enters at w. Water may be admitted to the casing b by the valve shown in Fig. 4. Water enters at 3 and is controlled by a needle valve 7 carrying a flange 8, the lift of which is adjustable by a split screw 9. Holes 10 admit air and drain away surplus water. Air may also be admitted through an aperture controlled by a shutter 12. The outlet passage 4 is controlled by a sliding plug 14 actuated by the driver through a Bowden or like mechanism. The Provisional Specification describes a construction in which the aperture in the plate s is not flanged and in which there is no water-admission means.

EXHAUST-SILENCERS.

117,868.—W. HOOTON, 12, Fenchurch Street, London.—Oct. 26th, 1917.—The exhaust is divided into two streams of equal intensity, which are passed through pipes of different lengths or bores in order to produce interference. In one form, Fig. 1, the exhaust pipe a opens into a chamber b provided with two tubes h, j leading to a single outlet l. The intensities of the two streams may be equalised by adjusting a pivoted plate c in the chamber b. In order to allow variation of the difference in length between the two tubes h, j, the outlet l is formed on a slidable tube k. In a modification, the plate c is fixed, and the adjustment of the intensities of the two streams is permitted by providing a slotted flange on the exhaust pipe a bolted to a flange on the member carrying the pipes h, j. Fig. 2 shows an arrangement in which the two streams pass through co-axial pipes of different bore, the streams re-uniting in an outlet pipe q. The pipe n has an extension t to facilitate its longitudinal adjustment relatively to the pipe m. In the case of multi-cylinder engines, two separate exhaust pipes A, B, each connected to half the total number of cylinders, are connected near their outlets by a passage C, Fig. 5.



Patent 117,868.



Patent 117,878.

FRICTION GEARING.

117,878.—J. KEITH and G. KEITH, 27, Farringdon Avenue, London.—Nov. 30th, 1917.—Relates to hand-power speed-multiplying gear for driving fans, etc. It comprises an outer race B and a fan, etc., spindle A between which are interposed pairs of friction-rollers C, D some of which are mounted on eccentric bushes and are automatically jammed into engagement with a force increasing with the load. In the form shown the race B is rotated by hand, and the rollers C, D, which are on relatively fixed axes d, f are pressed between A and B by a spring K acting through links g on the rollers D, and the rollers C are mounted on eccentric bushes e to cause them to jam. In a modification, a spring device similar to K is arranged inside the race B. Annular groves may be formed inside the race B to facilitate the squeezing out of the oil film from between the rollers and the race, and this race may be provided with side-flanges.

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EDITORIAL.

THE REBUILDING OF INDUSTRY.

After four years or more of unbroken struggle, the people of this country have at last emerged from the deep shadow of war. They have paid the price of liberty and, although at the moment of writing the details of the peace that is to be have not yet been determined, we are familiar enough with the broad principles upon which those details will be worked out. So far as they go they appear to be satisfactory, and are a necessary result of those victories which our armies have won in the field, and, above all, the inevitable consequence of the great victory which our Navy has secured for us on the seas. But, great as these victories have been—and we would not for a moment attempt to minimise them—we have to face the fact that peace, too, hath her victories " no less renowned than war." The age-long struggle which man has waged with the forces of nature, and the application of his discoveries to industrial affairs, have been marked by notable conquests, and as we stand face-to-face with the future we ask ourselves the question, " What new achievements do we hope to accomplish in the rebuilding of our various industries?"

It would require some confidence and an abundance of vision to attempt an answer to this question, but those are precisely the qualities that will be needed most in the great task of industrial reconstruction, and our industrial engineers will do well to take stock of their equipment in this respect. It is easy enough to deal in generalities or to pronounce pious platitudes but it will be quite another thing to give to them by patient, persevering application, anything like a really clearly defined meaning—a meaning that will be writ large in prosperous industries and happy homes. In achieving this, we shall undoubtedly have our victories, and it is because we realise how much they can contribute to these victories that we hope to see our industrial engineers in the foremost ranks of those who will be responsible for the reconstuction of our national life. It is not, perhaps, for us to say what positions they should occupy, but there is little doubt that their functions should be of both an advisory and executive character. They know, none better, what will be needed in the altered conditions, and in the working out of schemes their intimate knowledge of the available instruments, fit them pre-eminently for such tasks.

Our thoughts have been directed to the foregoing points by a perusal of the list of names which make up the new Standing Council on Post-War Priority which has been set up to assist the War Cabinet Committee. Although we are presented with the names of distinguished individuals, we are quite prepared for the information that the new body is not complete. A certain number of prominent industrial engineers figure on it, but unless there is to be some wider scheme of securing the representation of local industrial interests, the representation of this class is quite inadequate. There can be no more important subject of the next few years than that relating to the supply and distribution of raw materials, and it is upon the ability of such a body as the Standing Council to deal with it that the whole future of British industry depends. Our claim, therefore, for a wider utilisation of industrial engineers is thoroughly well founded. They have contributed without stint to the organisation of industry for war, and it will certainly fall to them to turn it once more to the pursuits of peace, but they cannot be expected

to do so either to their own satisfaction or to that of those who are most vitally concerned with this matter, unless they are given opportunities to advise on industrial requirements. Their place in the new order must be clearly defined, and their vast collective experience drawn upon to the uttermost.

Undoubtedly, the most immediate problem to be tackled will be the allotment of supplies of raw materials to those industries which are in a position to turn over to peace production. The War Cabinet Committee, before whom these matters will come, will find many difficulties in the rival claims for priority in the matter of supplies, and they will do well to be guided by those who have an expert knowledge of industrial needs. We hope, therefore, that behind the new authority on priority there is a very much wider advisory element. On the other hand, our industrial engineers, in order to get away with the peace programme, will have to make out a good case for their own supplies of materials, and, unless they are intimately in touch with the Standing Council, they will find it difficult to handle a problem which for them is full of other difficulties. Of secondary importance will be the adaptation of machinery to the needs of normal industry, though the quicker this is carried out the more readily will the work of manufacture be organised, provided, of course, the necessary supplies of both material and labour are forthcoming. The industrial engineer will have a great deal to do in marshalling his forces for the fresh struggle.

To many observers, the question of labour appears to present a great amount of perplexity, largely involved in the greater problem of demobilisation. Beyond the information that this is to be carried out gradually, and as far as possible by freeing those who have got jobs to go to, we know little of whatever scheme has been decided upon for the purpose. We believe that there will be work, with but little delay, for all who can be discharged from the Navy and the Army, though it is, perhaps, inevitable that during the transition stage, there should be some dislocation and a certain amount of hardship. British industry will have to start rebuilding its fabric with at least a million fewer hands and brains than when it buckled on its armour for the great fray. That, in itself, is a serious enough matter, because it is confronted with a great deal more to be done than it abandoned on that fateful day in August, 1914. Frankly, we have no fear as to the amount of work that will be available, or to the capacity of our engineers and their labour to carry it through. What we do fear is the lack of confidence and vision on the part of our governors and their innumerable officials to create the conditions precedent to success. If their failure to do this only ended with themselves, such incompetence would not much matter, but, unfortunately, the results would be far-reaching and of great seriousness. We are involved in a world-problem, and we cannot possibly afford to have our policies formulated by those who are still limited to the parochial point of view, however safe and satisfactory that may be.

The Ministry of Munitions, in the disposal and allocation of stocks of non-ferrous metals in their possession to consumers, will be prepared to pay broker and recognised intermediaries a commission of $\frac{1}{2}$ per cent, subject to cash payment for the material.

Trade Items, Notes, &c.

Although commonly regarded as an inland city, Gloucester is a port of some importance, possessing a dock system with a water area of about $12\frac{1}{2}$ acres, and being in communication with the Bristol Channel by way of the Gloucester and Berkeley Ship Canal. On the left-hand bank of this waterway a concrete shipbuilding yard was completed in the early part of the present year by the Gloucester Ferro-Concrete Shipbuilding Co. Ltd., one of the various undertakings in the United Kingdom working on the Mouchel-Hennebique system of construction. Excellent progress has been made on the building of the first four vessels laid down, and one of these was launched on November 23rd. The vessel is a sea-going barge of 1,000 tons deadweight capacity, for the Controller General of Merchant Shipbuilding, and has been built in accordance with the structural designs of Messrs. L. G. Mouchel and Partners, of Westminster, under the survey of Lloyd's Registry of Shipping.

Hydro Electric Power in France. -The department of La Lozère will shortly be endowed with some very important works which will impart to it an activity and vitality hitherto quite unknown in that district. This is due to the initiative of the P.L.M. Railway Co. which, in order to electrify its Chermont-Auvergne-Alais line, is constructing an enormous barrage capable of holding over 45 million cubic metres of water, capable of yielding a power of over 8,000 kilowatts. This barrage will be situated close to Pont-de-Montvert, at an altitude of 870 metres. The dam or supporting wall will be 40 metres high, and the fall of the water will be 490 metres. The perimeter of the lake secured by this captation of water will be 10 kilometres. Masonry work to the extent of 70,000 cubic feet will be required for the work, upon which a large body of men is already engaged. Some 30,000 tons of lime and cement will be needed, and the total expenditure will amount to some 20 million francs. As the company will not require all the power produced, several large works and factories are also to be erected in the neighbourhood.

A general discussion on "The Relation of Science to the Non-Ferrous Metals Industry" will form the central feature of the forthcoming annual general meeting of the Institute of Metals. At that meeting there will also be presented several important papers, the publication of which has been withheld owing to the operation of the Censorship. The meeting, which will be the first peace-time gathering of the Institute for five years, is, therefore, to be anticipated with great interest, as is also the annual May lecture, which will be delivered by Professor F. Soddy, F.R.S., M.A., on the subject of "Radio-activity." A local section of the Institute of Metals has been formed at Sheffield, the recently dissolved Sheffield Society of Applied Metallurgy forming the nucleus of the new section. A ballot for the election of members of the Institute of Metals will be taken on Wednesday, December 18th. The necessary membership application form, which is combined with an illustrated booklet, can be had from the Secretary, Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, London, S.W.1. The roll of the Institute has increased by over 200 during the current year, and in view of the advent of Peace it is expected that a total of 1,200 members will soon be recorded—and that within a few months of the Institute's tenth birthday.

A notable addition to the oil tank fleet of the Eagle Oil Transport Co. Ltd. was launched on the 4th inst. by Swan, Hunter and Wigham Richardson Ltd., Wallsend-on-Tyne. The vessel is designed to carry a total deadweight of 18,000 tons, and is the largest oil tanker afloat. She is 546 ft. in length, 68 ft. 7 in. in width, with a moulded depth of $42\frac{1}{4}$ ft. The "San Florentino" is built on the Isherwood system of longitudinal framing and has been measured for tonnage to pass through both the Panama and Suez Canals. The hull of the ship is divided into 13 oil-tight compartments, and fitted with four and a half miles of oil pipes. The system of piping is so arranged that the pumps can discharge the vessel by grouping together a given number of oil holds in every conceivable way. The pipes both for loading oil and discharging it are separated by valves in such a manner that four different grades of oil can be either loaded or dsicharged simultaneously without getting mixed. The "San Florentino" is fitted with steam-heating apparatus, refrigerating plant, a hospital, wireless, and a complete installation of auxiliary machinery. The engines consist of a set of compound-geared turbines, so arranged that they can each run independently or be coupled to gearing to work the propellor.

BALATA BELTING.

By R. Roberts.

These belts are made by sewing and cementing together layers of textile fabric. The materials used and the processes they go through before the finished product is obtained vary greatly, and the belts made by one manufacturer do not necessarily possess similar capacities and characteristics to those made by a competitor. Although each manufacturer's article is the best on the market, no definite or reliable experimentally determined or theoretically deduced rules have been published that will guide and help an engineer to design a power drive for these belts.

A very common rule is that the nett or dynamic pull may be 16 lbs. per ply per inch width. Such a rule, in the face of experiments and deductions that have been carried out upon leather belts, is only apt to produce drives which are either needlessly expensive to put down or expensive in upkeep, and nothing is so liable to advertise bad designing and create prejudice against excellent material as rules-of-thumb applied indiscriminately.

In a previous article, the author attempted to show how a belt drive should be designed and, as far as he was able, the reasons which led him to formulate such rules for leather belts. In texture and pliability, the well-made balata belt is very similar to leather; and, all-in-all considered, he thinks similar rules should be applied to balata belting similar to those he then suggested for leather belts.

The above-mentioned rules were suggested because of three broad arguments:—

(1) That the size of the pulley has a great influence upon the pull that may be loaded upon a belt, irrespective (or nearly so) of the belt speed.

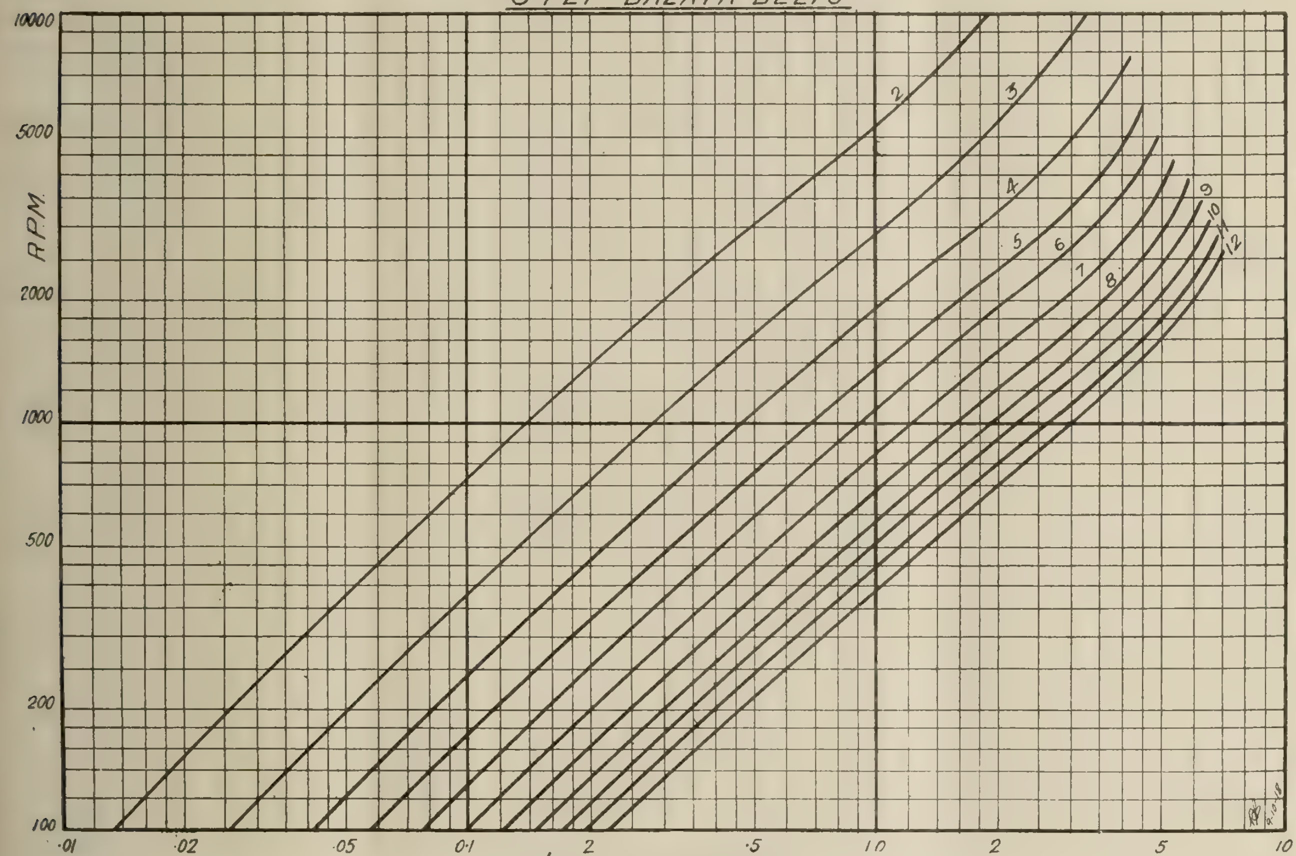
(2) That at higher speeds not only does the belt grip the pulley better, *i.e.*, the coefficient of friction between pulley and belt becomes greater, but the strain in the fibres due to maximum stress does not attain the value that is obtained by static tests.

(3) That the centrifugal forces due to the weight of the belt itself decrease the dynamic load that may be applied by an amount proportional to the square of the belt speed.

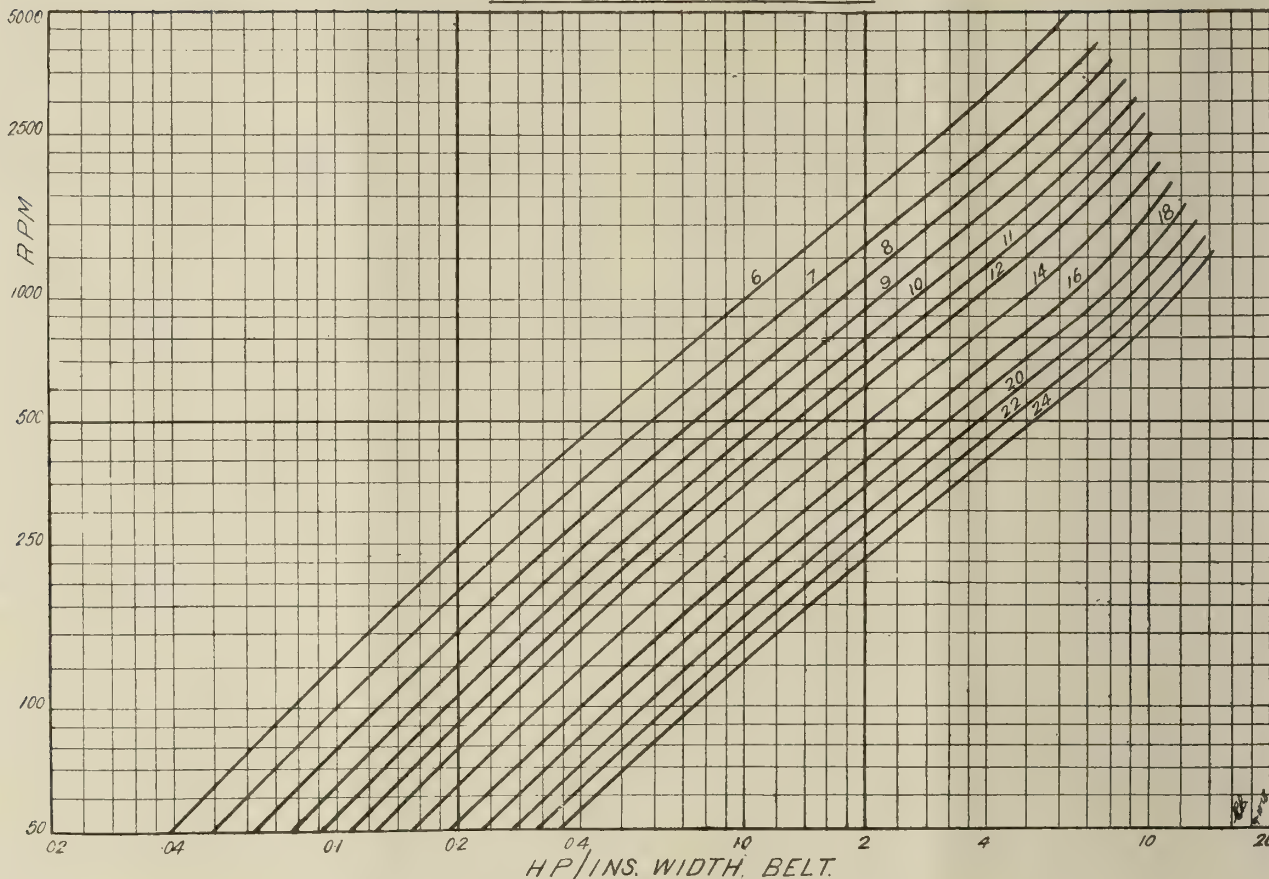
Upon these three broad fundamentals, the author suggested taking a pulley 40 in. in diameter as a basis and a general formulæ to give the nett pull as follows:—

$P = A\ Bv - Cv^2$. Where P=pull in lbs., v=belt-speed in ft./min. A, B and C=constants.

—3 PLY BALATA BELTS—



—4 PLY BALATA BELTS.—



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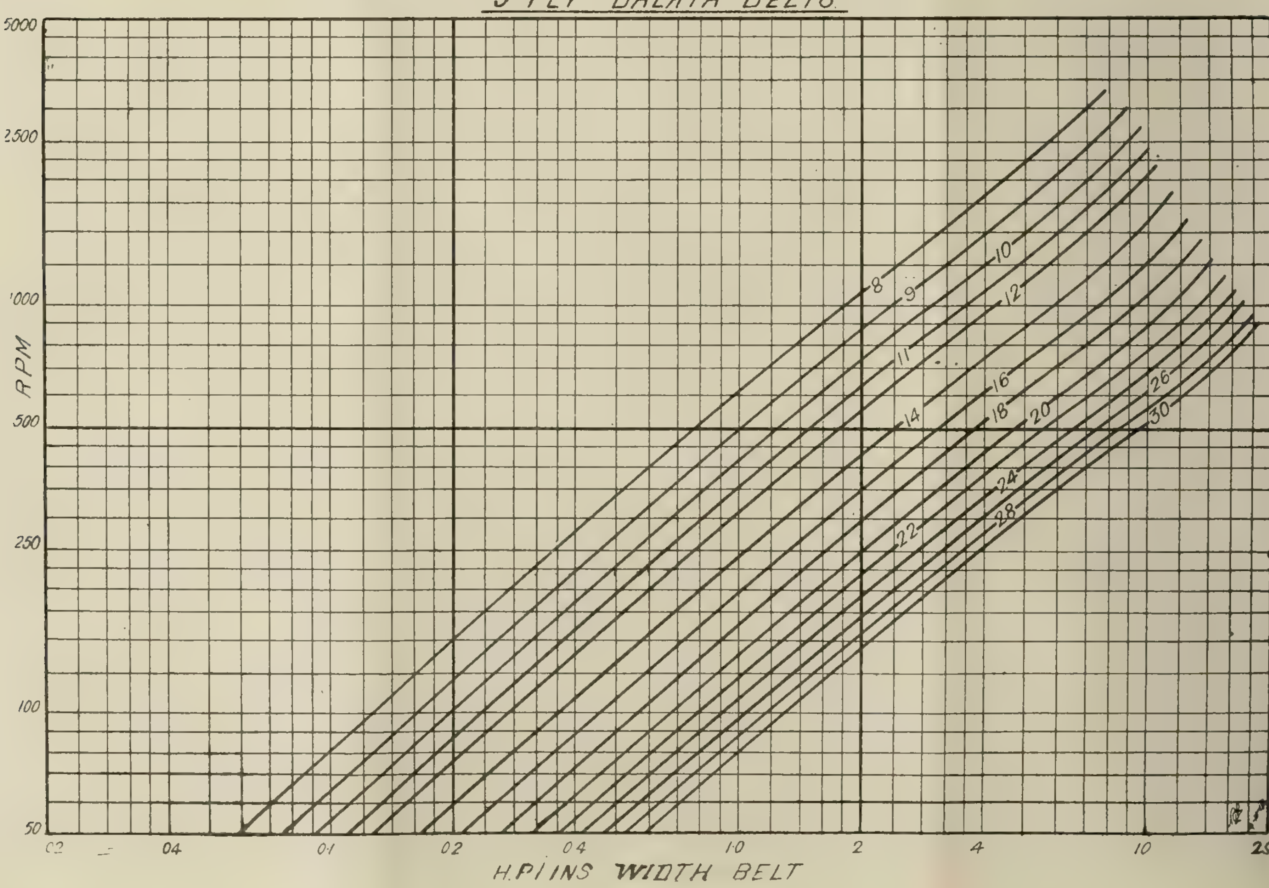

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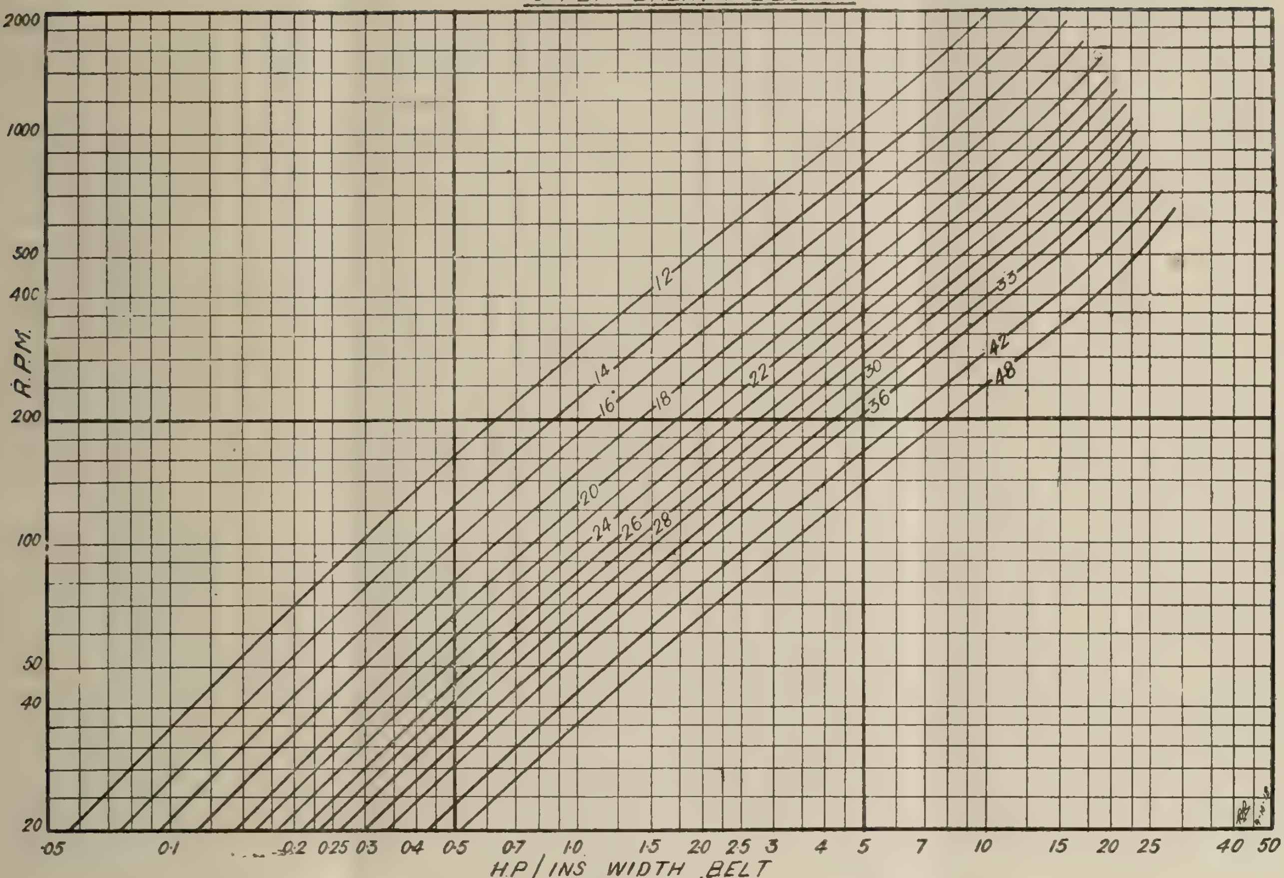

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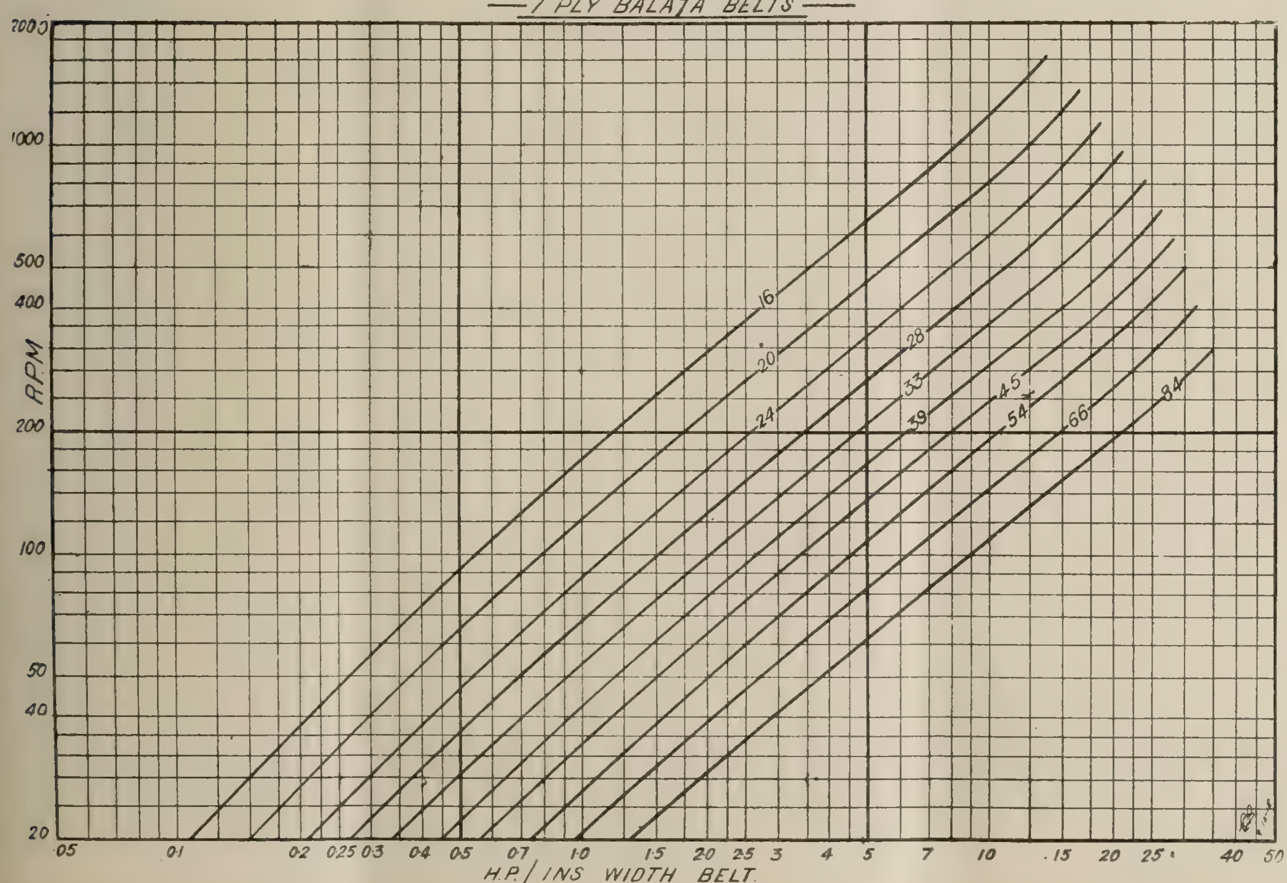


Inserting suitable values for these constants, he obtains formulæ for balata belting as follows, where P is the nett pull in lbs. per inch width of belt.

$$3\text{ ply}\quad P_3 = 30\ .007v - .5\left(\frac{v}{1000}\right)^2$$

$$4\text{-ply}\quad P_4 = 40\ .011v\quad .75\left(\frac{v}{1000}\right)^2$$

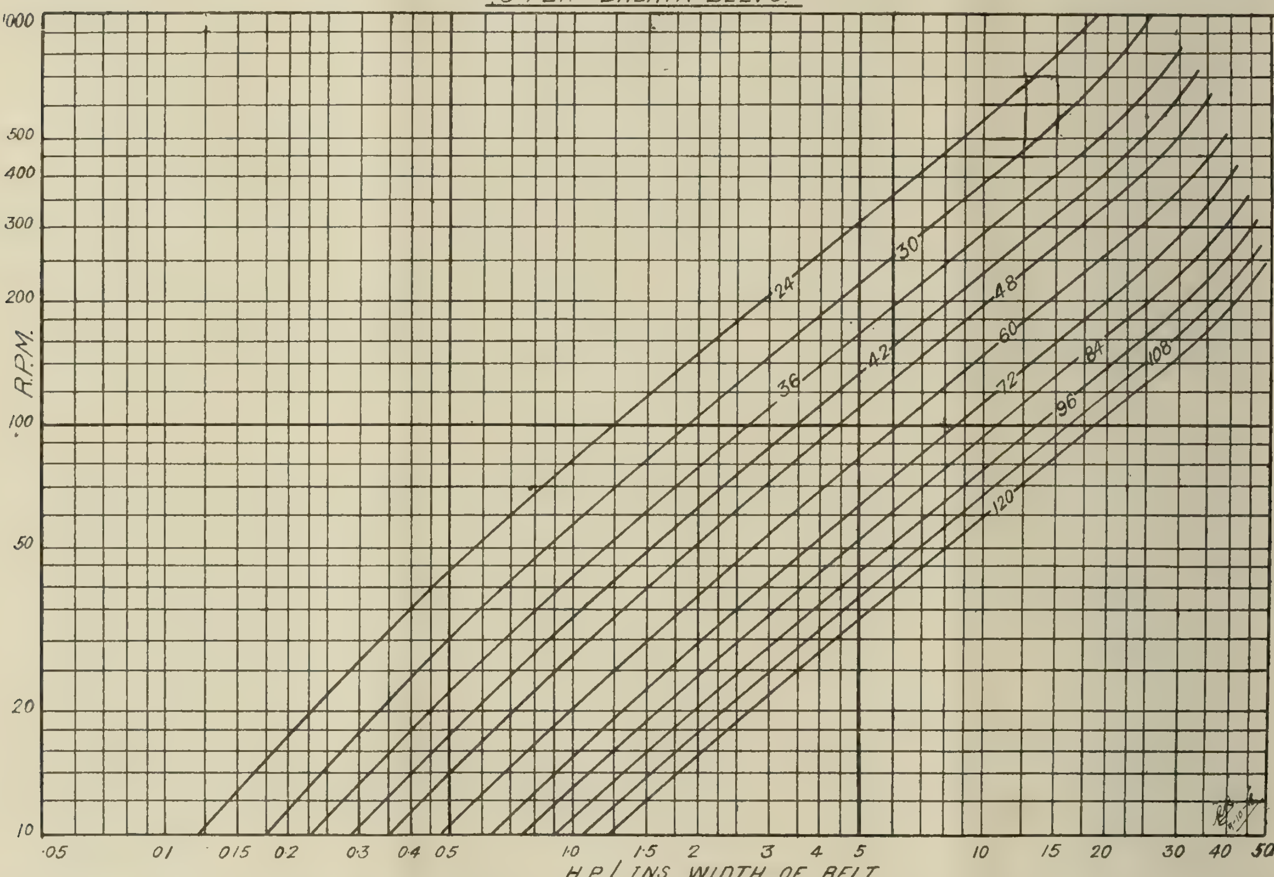
$$5\text{-ply}\quad P_5 = 50\ .015v - 1.1\left(\frac{v}{1000}\right)^2$$

$$6\text{-ply}\quad P_6 = 60\ .018v\quad 1.5\left(\frac{v}{1000}\right)$$

$$7\text{-ply}\quad P_7 = 70\ .020v - 1.9\left(\frac{v}{1000}\right)^2$$

$$8\text{-ply}\quad P_8 = 80\ .022v - 2.2\left(\frac{v}{1000}\right)^2$$

—8 PLY BALATA BELTS.—



To compensate for differences in pulley diameters these values for P were multiplied by factors given in the following tables:—

3 ply. Dia.	Factor.	4-ply. Dia.	Factor.	5-ply. Dia.	Factor.
2	·26	6	·39	8	·39
3	·34	7	·44	9	·43
4	·41	8	·48	10	·47
5	·46	9	·52	11	·50
6	·51	10	·55	12	·54
7	·55	11	·59	14	·60
8	·59	12	·61	16	·65
9	·63	14	·67	18	·70
10	·66	16	·72	20	·74
11	·69	18	·75	22	·78
12	·72	20	·79	24	·81
14	·76	22	·82	26	·84
16	·80	24	·85	28	·87
18	·83	26	·88	30	·91

6 ply. Dia.	Factor.	7-ply. Dia.	Factor.	8-ply. Dia.	Factor.
12	·46	18	·60	24	·71
14	·53	20	·65	26	·76
16	·59	22	·70	28	·80
18	·64	24	·74	30	·84
20	·69	26	·79	33	·89
22	·74	28	·82	36	·95
24	·78	30	·86	42	1·03
26	·82	33	·90	48	1·10
28	·84	36	·95	60	1·21
30	·87	42	1·02	72	1·30
33	·92	48	1·08	84	1·36
36	·96	60	1·14	96	1·44
42	1·01	72	1·24	108	1·49
48	1·06	84	1·29	120	1·52

Diameters in inches.

By applying the above formulæ and factors to any particular belt and pulley, a series of values for horse power per inch width of belt may be obtained, and if a series of diameters are taken, a whole series of curves may be plotted, showing the horse power per inch width of belt against revolutions per minute for various sizes of pulleys.

The accompanying curves give such values for various-ply balata belts, and are plotted on logarithmic paper, so that a very large range is obtained with proportionate accuracy throughout.

These suggested belt powers are not the maximum values the belt may carry, but rather such powers as will permit of reasonable life to the belt, and also put such loads upon bearings as will not cause trouble. One factor that is often lost sight of is that the bearings and shafts in a power belt drive are as important as, and as dependent upon, the design of the belt drives themselves.

HEAT APPLIED TO ENGINEERING.

By Prof. W. W. Haldane Gee, B.Sc., M.Sc.Tech.

(*Continued from page 34.*)

Thermo-Electric Thermometry.

In 1821 Seebeck showed that a difference of electrical pressure could be directly produced by maintaining a difference of temperature between the junctions of two metals. He used the apparatus shown in Fig. 16. It consists of a short rod of bismuth, which completes the circuit of a strip of copper. Inside the copper is a pivoted magnetic needle. On heating

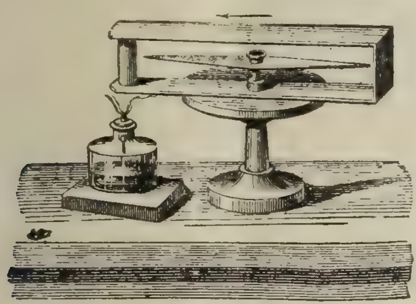


Fig. 16. -Seebeck's Experiment.

the lower junction of the metals with a spirit lamp he found that the needle was deflected, indicating the production of an electric current passing in the direction shown by the arrow. By using different metals he was enabled to arrange them in the following order:—

+
Bismuth.
Nickel.
Copper.
Lead.
Tin.
Gold.
Silver.
Zinc.
Iron.
Antimony.
—

A metal higher in the list, when connected with one lower, gave a current passing through the hotter

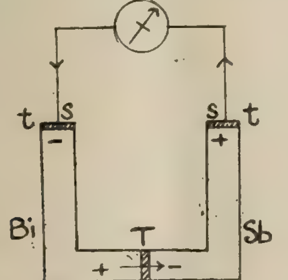


Fig. 17.—Thermo couple Circuit.

junction from the former to the latter metal. Subsequent experiments lead to the conclusion that the effect would be the same when the metals are united by a third metal (see Fig. 17), such as solder *s*, provided that the temperature T at the ends of the metals and the solder was kept the same. Further, copper leads could be soldered at *s* and *s* to the cooler ends, and the same pressure will be produced as when the metals are directly connected, provided that the copper joints and solder are at the same lower temperature *t*. In the circuit a galvanometer may be included as shown in the diagram. The bismuth here is called the *positive*, and the antimony the *negative* metal; but the end of the antimony is

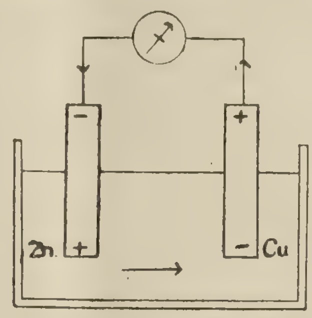


Fig. 18.—Galvanic Cell Circuit.

the *positive pole*, and the end of the bismuth the *negative pole*. This is like the case of a galvanic cell (see Fig. 18), where the zinc is the positive plate and bears the negative pole, whilst the copper is the negative plate with a positive pole. The meaning of the + and — signs at the top and bottom of the previous table will now be understood. The further the metals are apart in the list the greater will be the electrical pressure obtained for one degree difference in temperature between the junctions. In order to find this value, which is often called the *thermometric power*, the arrangement shown in Fig. 19 is convenient when we are experimenting with metals which can be easily obtained in the form of thin wires. Within the tube A, which contains oil, is the junction of the two metals. By heating the liquid in the surrounding bath, the junctions can be

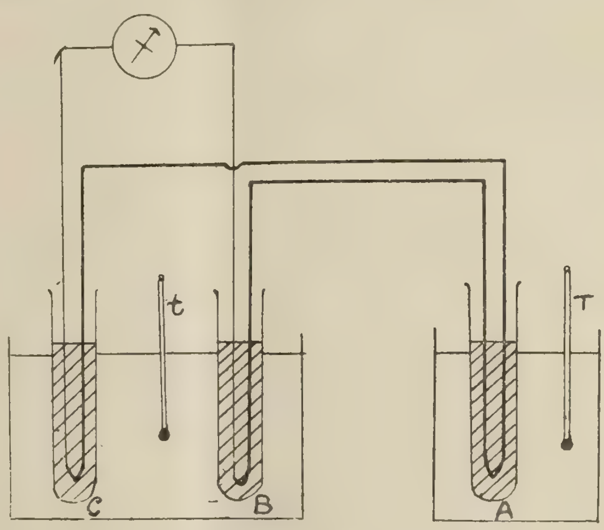


Fig. 19.—Apparatus for Thermo-electric Tests.

raised, as indicated by a thermometer, to a temperature T. The cold junctions are in the tubes B and C, which are maintained at a temperature *t*. By means of this apparatus, or some modifications of it, the numbers in the next table have been obtained.

It gives the thermo-electric power when T is in the region of 15° C. The pressures are in *microvolts*, that is, in millionths of a volt. Lead is taken as the standard metal.

THERMO-ELECTRIC POWERS.

Bismuth, pressed commercial wire	+97
,, ,, pure ,,	+89
German silver	+11.8
Cobalt	+22
Lead	0
Tin	− 0.1
Copper, commercial	− 0.1
Platinum	− 0.9
Antimony, pressed wire	− 2.8
Silver, pure hard	− 3.0
Copper, electrolytic	− 3.3
Iron, pianoforte wire	−17.5
Antimony, crystal along axis	−22.6
Selenium	−807

The position of a substance in the table depends, as will be seen, on its purity and physical condition. The table enables the thermometric power to be obtained for any pair in the list.

Ex. 1.—The pressure between cobalt and lead is 22 microvolts, and the current goes from cobalt to lead through the hot junction.

Ex. 2.—That between cobalt and silver is $22-(-3)=25$, and the current goes from the former to the latter through the hot junction.

When the difference of temperature between the junctions is relatively small the pressure may be assumed to be directly as this difference. This is understood to be the case in the next example:—

Ex. 3.—A copper-iron couple was used with the cold junction at 0° C., and the hot at 16° C., and was connected with a galvanometer. The total resistance in circuit being 26 ohms, find the strength of the current.

Ans.—With commercial copper and iron wire—

$$\text{Current} = \frac{17.4 \times 16}{26} = 10.7 \text{ micro-amperes.}$$

Instead of a single couple a battery of couples may be used, arranged as shown in Fig. 20, in which one

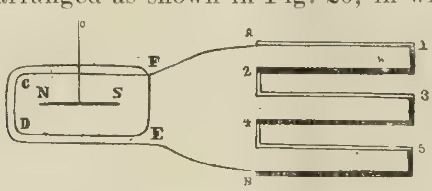


FIG. 20.—ARRANGEMENT OF THERMOPILE.

set of junctions is kept at a highe rtemperature than the other set. Many couples may be arranged compactly if we pay due regard to the necessary insulation between the metals, and so form a *thermopile*.

Thermal batteries of this type are of great importance in measurements relating to radiant heat from coal, gas, and electric fires. They may be placed some distance away from the source of heat and yet give measurable pressures.

Ex. 4.—Find the voltage produced with 50 bismuth and antimony bars for a temperature difference of $\frac{1}{1000}$ °C.

Ans.—Taking the pressure as $97-(-2.8)=99.8$, or say 100, we have:—

$$50 \times 100 \times \frac{1}{1000} = 5 \text{ microvolts.}$$

Commercial Thermo-Piles.

The thermo-pile directly transforms heat into electrical energy. Many attempts have been made to accomplish this conversion with sufficient efficiency. Probably one of the most successful designs is that of Gülcher, which is shown in Fig. 21. The junctions are of German silver and a special

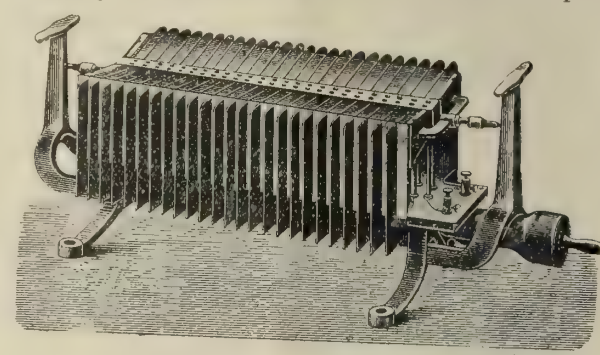


FIG. 21.—GULCHER'S THERMOPILE.

alloy, which are heated by a double row of small bunsen burners. The cold junctions are air-cooled, this cooling being assisted by copper vanes. The generator is made in three sizes:—

	No. 1.	No. 2.	No. 3.
No. of junctions	26	50	66
Volts	1.5	3	4
Resistance, ohms	0.25	0.5	0.65
Approx. coal gas used in cubic feet per hour	2.6	4.9	6.4

The above data will enable some interesting conclusions to be deduced:—

Ex .1.—Find the maximum current obtainable on short circuit from No. 3.

Ans.—$\text{Amperes} = \frac{4}{0.65} = 6$ nearly.

Ex. 2.—Find the maximum power with No. 3.

Ans.—It is shown in books on electricity that the maximum power output is when the external resistance and the internal resistance are equal. When this is the case the current will be nearly 3 amperes, and the pressure at the terminals will be half the above tabulated value, hence the maximum output will be $2 \times 3 = 6$ watts.

Ex. 3.—Find the number of Board of Trade units (kilowatt-hours) obtainable by the consumption of 1,000 cubic feet of coal gas.

Ans.—Since 6.4 cubic feet of gas give 6 watt-hours, then 1,000 cubic feet will produce, say, 900 watt-hours, or 9/10ths of a Board of Trade unit.

Hence from the last example, if gas costs 2s. 6d. per 1,000 cubic feet, this thermal generator will produce a Board of Trade unit for 2s. 9d.

This is a very high figure compared with the cost of electrical energy from central stations, nevertheless, it compares quite favourably with the cost when primary cells are used, hence thermo-generators may be of advantage when only small powers are

required. They can also be used for charging small storage cells.

Thermo-generators have been made in England in accordance with the patents of Mr. H. B. Cox. In the larger sizes of his design water cooling is adopted, and they give an open circuit voltage of 8.5 with an internal resistance of 3.5 ohms. He has adopted them for driving electric fans, medical coils, and for electro-plating.

Tait's Researches.

Following a suggestion of Sir W. Thomson, Professor Tait made a thorough examination of the laws of thermo-electricity. The results were published in the Transactions of the Royal Society of Edinburgh for 1872-3. Some of the results of his experiments are shown in the table which follows :—

THERMO-ELECTRIC POWERS.

In C.G.S. units, θ = mean temperature of junctions Limits from $-18°$ to 416°C. Lead taken as standard.

Iron	$-1734 + 4.87\theta$
Steel	$-1139 + 3.28\theta$
Platinum-Iridium (10% Ir.)	$-596 + 1.34\theta$
Copper	$-136 - 0.95\theta$
Lead	0
Nickel (to 175°C)	$+2204 + 5.12\theta$

The method of using tables arranged in accordance with the plan of the above is shown by the examples :—

Ex. 1.—Find the voltage produced by a copper-iron couple, the junctions being at 0° and 100° C.

Ans.—

$$\text{Copper} = -136 - 0{\cdot}95\theta$$
$$\text{Iron} = -1734 + 4.87\theta$$
$$\text{Difference} = +1598 - 5.82\theta$$

For θ the mean temperature of the functions must be taken. This is $\frac{0+100}{2} = 50$.

The pressure per degree is then : $+1598 - (5.82 \times 5) = 1307$; and for $100 - 0$ degrees $= 130700$.

To express this in volts we must divide by 10^8 (for 1 volt $= 10^8$ C.G.C. units), and then to convert into microvolts multiply by 10^6. Hence :

$$\frac{130700}{10^8} \times 10^6 = 1307 \text{ microvolts.}$$

Ex. 2.—If $t = 0$ and $T = 550$, find the voltage for a copper-iron couple.

Ans.—

$$\theta = \frac{0 + 550}{2} = 275$$

Thermo-electric power $= [1598 - (5.82 \times 275)] = 0$ nearly.

At this value of θ the thermo-electric power vanishes. It is called the *neutral* temperature. Thus

if $t = 100$ and $T = 440$, or
if $t = 200$ and $T = 350$,

since in each case the mean is 275, there will be no pressure.

Ex. 3.—Find the neutral temperature of platinum and iron.

Ans.—Taking the value of platinum as $-260 + 0.75\theta$, and that of iron as given in the preceding table, we write :—

$$-960 + 0.75\theta = -1734 + 4.87\theta \text{ and } \theta = 358 \text{ nearly.}$$

Ex. 4.—If tin and iron used as a couple give a thermo-electric value represented by $43 - 0.55\theta$, find the neutal temperature.

Ans.—

$$43 - 0.55\theta = 0 \text{ and } \theta = 328 \text{ nearly.}$$

The values for couples derived from the preceding table give for the thermo-electric power expressions of the general form :—

$$\pm A \pm B\theta$$

where A and B are constants, and the electric pressure produced for $t = 0$ and any temperature T will be :

$$\pm T(A \pm \frac{T}{2}B\theta) = \pm AT \pm \frac{B}{2}T^2.$$

Suppose for ease of calculation we take A and B exact numbers such as $A = 1{,}600$ and $B = -6$, which constants will represent the case of special samples of iron and copper. The above expression now becomes :—$1{,}600T - 3T^2$.

From this the resultant value of the pressure can be calculated for different values of T, and the results

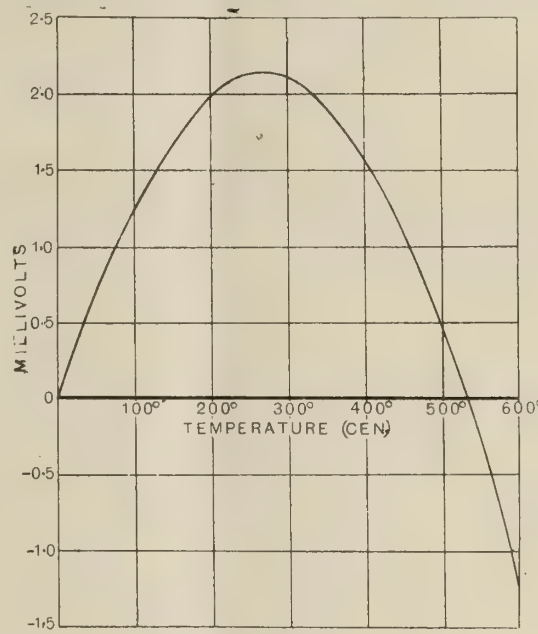


FIG. 22.

can be expressed graphically, as shown in Fig. 22. The diagram shows that the pressure reaches a maximum when $T = 266.6$, and when $T = 533.3$, there is no pressure; but for temperatures beyond T the direction of the pressure reverses. It is evident from this diagram that an iron-copper couple would be unsuitable for measuring temperatures through a large range of temperature. For this purpose we must use couples which give as nearly as possible straight line diagrams with a zero point entirely outside our range of measurements.

History of Thermo-Electric Pyrometry.

That thermo-electric couples could be used for high temperature measurements was first realised by Becquerel in 1826. He used a platinum-palladium junction. In 1836 Pouillet made extensive use of an iron-platinum couple, but Regnault, about ten years later, did not succeed in getting satisfactory results

with these metals. This was probably due to the want of a suitable galvanometer. The great authority of Regnault retarded the use of thermo-electric methods until in 1863 E. Becquerel studied the platinum-palladium, used by his father, and other couples. Following the work of Tait just described, an extended research of great practical value was made by Le Chatelier in 1886-7, on platinum and platinum alloys. It is chiefly due to this work that exact thermo-electric pyrometry has been placed on a sound basis, but much is also due to the patient investigations of Barus, who in 1889 issued from the Physical Laboratory of the United States Geological Survey a very valuable bulletin "On the Thermo-Electric Measurement of High Temperatures." By 1900, the standardisation of thermo-couples was systematised at the Phys. Tech. Reichsanstalt. and for a number of years a special section of the National Physical Laboratory has been devoted to the testing of commercial pyrometers. *(To be continued.)*

ENGINEERING LAY-OUT ARRANGEMENTS AND TENDER DRAWINGS.

By Douglas Wilson, A.M.I.Mech.E.

(Continued from Vol. VI., p. 384.)

A compact and efficient separator is shown at Fig. 26; this drier is made by Messrs. Princeps, of Sheffield, and differs somewhat from the ordinary type, as will be seen from the drawing. Steam entering the inlet branch immediately expands to the larger area of the body and passes through the dryer

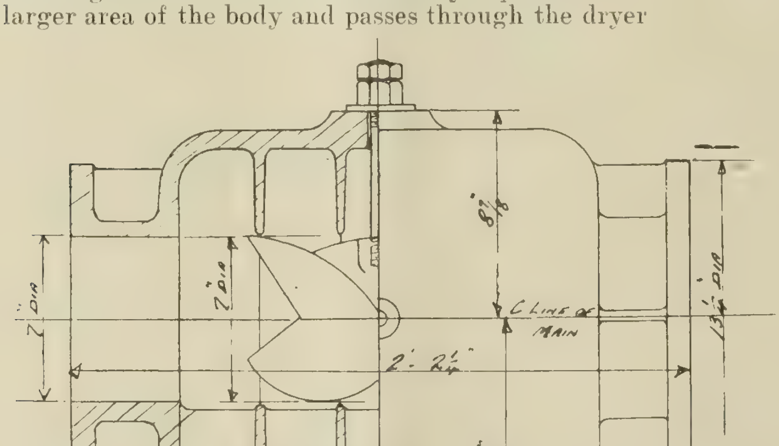


Fig. 26.

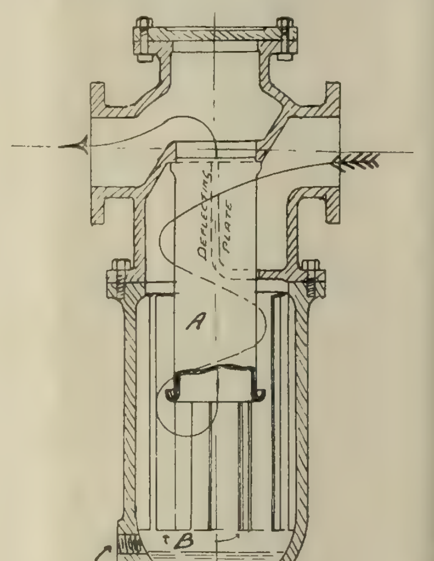


Fig. 27.

Engineering Lay-out.

in a spiral motion, due to the twisted blades forming the central battery of the dryer. In its passage it is sheared or licked by the grid plates which pass around the spiral plate. The water collected passes down each plate and forward into the bottom cham-

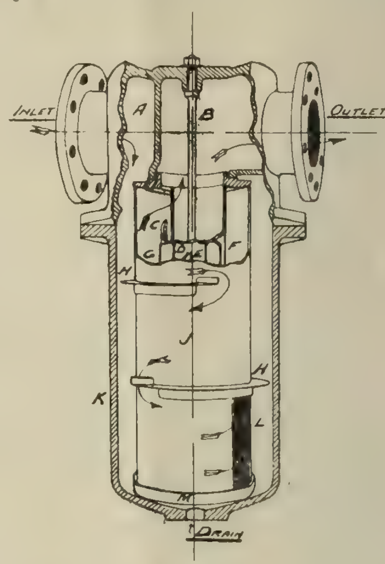


Fig. 28.

ber, which is not in contact with the passing steam and therefore cannot be taken up or carried forward. In this separator it does not appear possible for any baffling to take place. This seems to be a very desirable feature. Owing to the central spiral the total length over flanges is, however, rather more

Weights of Lengths of Rolled Steel Sections.

Beam 20 in. × $7\frac{1}{2}$ in. × 89 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	7 3 22	0 15 3 16	1 3 3 10	1 11 3 4	1 19 2 26	2 7 2 20	2 15 2 14	3 3 2 8	3 11 2 2	0
1	0 3 5	8 2 27	0 16 2 21	1 4 2 15	1 12 2 9	2 0 2 3	2 8 1 25	2 16 1 19	3 4 1 13	3 12 1 7	1
2	1 2 10	9 2 4	0 17 1 26	1 5 1 20	1 13 1 14	2 1 1 8	2 9 1 2	2 17 0 24	3 5 0 18	3 13 0 12	2
3	2 1 5	10 1 9	0 18 1 3	1 6 0 25	1 14 0 19	2 2 0 13	2 10 0 7	2 18 0 1	3 5 3 23	3 13 3 7	3
4	3 0 20	11 0 14	0 19 0 8	1 7 0 2	1 14 3 24	2 2 3 18	2 10 3 12	2 18 3 6	3 6 3 0	3 14 2 22	4
5	3 3 25	11 3 19	0 19 3 13	1 7 3 7	1 15 3 1	2 3 2 23	2 11 2 17	2 19 2 11	3 7 2 5	3 15 1 27	5
6	4 3 2	12 2 24	1 0 2 18	1 8 2 12	1 16 2 6	2 4 2 0	2 12 1 22	3 0 1 16	3 8 1 10	3 16 1 4	6
7	5 2 7	13 2 1	1 1 1 23	1 9 1 17	1 17 1 11	2 5 1 5	2 13 0 27	3 1 0 21	3 9 0 15	3 17 0 9	7
8	6 1 12	14 1 16	1 2 1 0	1 10 0 22	1 18 0 16	2 6 0 10	2 14 0 4	3 1 3 26	3 9 3 20	3 17 3 14	8
9	7 0 17	15 0 11	1 3 0 5	1 10 3 27	1 18 3 21	2 6 3 15	2 14 3 9	3 2 3 3	3 10 2 25	3 18 2 19	9

Weight of Beam advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight
	7·41	14·83	22·25	1 1·66	1 9·08	1 16·5	1 23·91	2 3·33	2 10·74	2 18·16	2 25·58	3 5·0	

Weights of Lengths of Rolled Steel Sections.

Beam 20 in. × $7\frac{1}{2}$ in. × 89 lbs. per foot.

[ALL RIGHTS RESERVED.]

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 19 1 24	7 18 3 20	11 18 1 16	15 17 3 12	19 17 1 8	23 16 3 4	27 16 1 0	31 15 2 24	35 15 0 20	0
10	0 7 3 22	4 7 1 18	8 6 3 14	12 6 1 10	16 5 3 6	20 5 1 2	24 4 2 26	28 4 0 22	32 3 2 18	36 3 0 14	10
20	0 15 3 16	4 15 1 12	8 14 3 18	12 14 1 4	16 13 3 0	20 13 0 24	24 12 2 20	28 12 0 16	32 11 2 12	36 11 0 8	20
30	1 3 3 10	5 3 1 6	9 2 3 2	13 2 0 26	17 1 2 22	21 1 0 18	25 0 2 14	29 0 0 10	32 19 2 6	36 19 0 2	30
40	1 11 3 4	5 11 1 0	9 10 2 24	13 10 0 20	17 9 2 16	21 9 0 12	25 8 2 8	29 8 0 4	33 7 2 0	37 6 3 24	40
50	1 19 2 26	5 19 0 22	9 18 2 18	13 18 0 14	17 17 2 10	21 17 0 6	25 16 2 2	29 15 3 26	33 15 1 22	37 14 3 18	50
60	2 7 2 20	6 7 0 16	10 6 2 12	14 6 0 8	18 5 2 4	22 5 0 0	26 4 1 24	30 3 3 20	34 3 1 16	38 2 3 12	60
70	2 15 2 14	6 15 0 10	10 14 2 6	14 14 0 2	18 13 1 26	22 12 3 22	26 12 1 18	30 11 3 14	34 11 1 10	38 10 3 6	70
80	3 3 2 8	7 3 0 4	11 2 2 0	15 1 3 24	19 1 1 20	23 0 3 16	27 0 1 12	30 19 3 8	34 19 1 4	38 18 3 0	80
90	3 11 2 2	7 10 3 26	11 10 1 22	15 9 3 18	19 9 1 14	23 8 3 10	27 8 1 6	31 7 3 2	35 7 0 26	39 6 2 22	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t c. q. lb.	Weight
	39 14 2 16	79 9 1 4	119 3 3 20	158 18 2 8	198 13 0 24	238 7 3 12	278 2 2 0	317 17 0 16	357 11 3 4	397 6 1 20	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × 7½ in. × 100 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	8 3 20	0 17 3 12	1 6 3 4	1 15 2 24	2 4 2 16	2 13 2 8	3 2 2 0	3 11 1 20	4 0 1 12	0
1	0 3 16	9 3 8	0 18 3 0	1 7 2 20	1 16 2 12	2 5 2 4	2 14 1 24	3 3 1 16	3 12 1 8	4 1 1 0	1
2	1 3 4	10 2 24	0 19 2 16	1 8 2 8	1 17 2 0	2 6 1 20	2 15 1 12	3 4 1 4	3 13 0 24	4 2 0 16	2
3	2 2 20	11 2 12	1 0 2 4	1 9 1 24	1 18 1 16	2 7 1 8	2 16 1 0	3 5 0 20	3 14 0 12	4 3 0 4	3
4	3 2 8	12 2 0	1 1 1 20	1 10 1 12	1 19 1 4	2 8 0 24	2 17 0 16	3 6 0 8	3 15 0 0	4 3 3 20	4
5	4 1 24	13 1 16	1 2 1 8	1 11 1 0	2 0 0 20	2 9 0 12	2 18 0 4	3 6 3 24	3 15 3 16	4 4 3 8	5
6	5 1 12	14 1 4	1 3 0 24	1 12 0 16	2 1 0 8	2 10 0 0	2 18 3 20	3 7 3 12	3 16 3 4	4 5 2 24	6
7	6 1 0	15 0 20	1 4 0 12	1 13 0 4	2 1 3 24	2 10 3 16	2 19 3 8	3 8 3 0	3 16 2 20	4 6 2 12	7
8	7 0 16	16 0 8	1 5 0 0	1 13 3 20	2 2 3 12	2 11 3 4	3 0 2 24	3 9 2 16	3 18 2 8	4 7 2 0	8
9	8 0 4	16 3 24	1 5 3 16	1 14 3 8	2 3 3 0	2 12 2 20	3 1 2 12	3 10 2 4	3 19 1 24	4 8 1 16	9

Weight of Beam advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight
	8·34	16·68	25·02	1 5·36	1 13·70	1 22·04	2 2·38	2 10·72	2 19·06	2 27·40	3 7·74	3 16	

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × 7½ in. × 100 lbs. per foot.

[ALL RIGHTS RESERVED.]

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 9 1 4	8 18 2 8	13 7 3 12	17 17 0 16	22 6 1 20	26 15 2 24	31 5 0 0	35 14 1 4	40 3 2 8	0
10	0 8 3 20	4 18 0 24	9 7 2 0	13 16 3 4	18 6 0 8	22 15 1 12	27 4 2 16	31 13 3 20	36 3 0 24	40 12 2 0	10
20	0 17 3 12	5 7 0 16	9 16 1 20	14 5 2 24	18 15 0 0	23 4 1 4	27 13 2 8	32 2 3 12	36 12 0 16	41 1 1 20	20
30	1 6 3 4	5 16 0 8	10 5 1 12	14 14 2 16	19 3 3 20	23 13 0 24	28 2 2 0	32 11 3 4	37 1 0 8	41 10 1 12	30
40	1 15 2 24	6 5 0 0	10 14 1 4	15 3 2 8	19 12 3 12	24 2 0 6	28 11 1 20	33 0 2 24	37 10 0 0	41 19 1 4	40
50	2 4 2 16	6 13 3 20	11 3 0 24	15 12 2 0	20 1 3 4	24 11 0 8	29 0 1 12	33 9 2 16	37 18 3 20	42 8 0 24	50
60	2 13 2 8	7 2 3 12	11 12 0 16	16 1 1 20	20 10 2 24	25 0 0 0	29 9 1 4	33 18 2 8	38 7 3 12	42 17 0 16	60
70	3 2 2 0	7 11 3 4	12 1 0 8	16 10 1 12	20 19 2 16	25 8 3 20	29 18 0 24	34 7 2 0	38 16 3 4	43 6 0 8	70
80	3 11 1 20	8 0 2 24	12 10 0 0	16 19 1 4	21 8 2 8	25 17 3 12	30 7 0 16	34 16 1 20	39 5 2 24	43 15 0 0	80
90	4 0 1 12	8 9 2 16	12 18 3 20	17 8 0 24	21 17 2 0	26 6 3 4	30 16 0 8	35 5 1 12	39 14 2 16	44 3 3 20	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight
	44 12 3 12	89 5 2 24	133 18 2 8	178 11 1 20	223 4 1 4	267 17 0 16	312 10 0 0	357 2 3 12	402 15 2 24	446 8 2 8	

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Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues

ENGINEERING APPOINTMENTS OPEN.

TRADE ITEMS, NOTES, &c.

A company has been formed in Sweden under the style of the Electro-Alkali Company, with a view to manufacturing chloride of lime and other products. The process will be based on the most modern Siemens and Halske methods, and the output of chloride of lime is calculated at some 2,000 tons to 4,000 tons annually. The new company is negotiating about a suitable site for the works.

Metallurgy in Indo-China.—Messrs. Robert Guerin and Thiard have just completed the construction of three locomotives at Haipong. These gentlemen, who have done a great deal during the war to develop trade here, have rendered great services to the colony just at a time when it was impossible to obtain machinery of any kind, however much needed, from Europe. At the present time the works of Guerin and Thiard are turning out boilers for 25-H.P. horizontal steam engines, electric pumps with a vertical steam engine, Worthington pumps, copper and brass boiler fittings, lathes and steam launches.

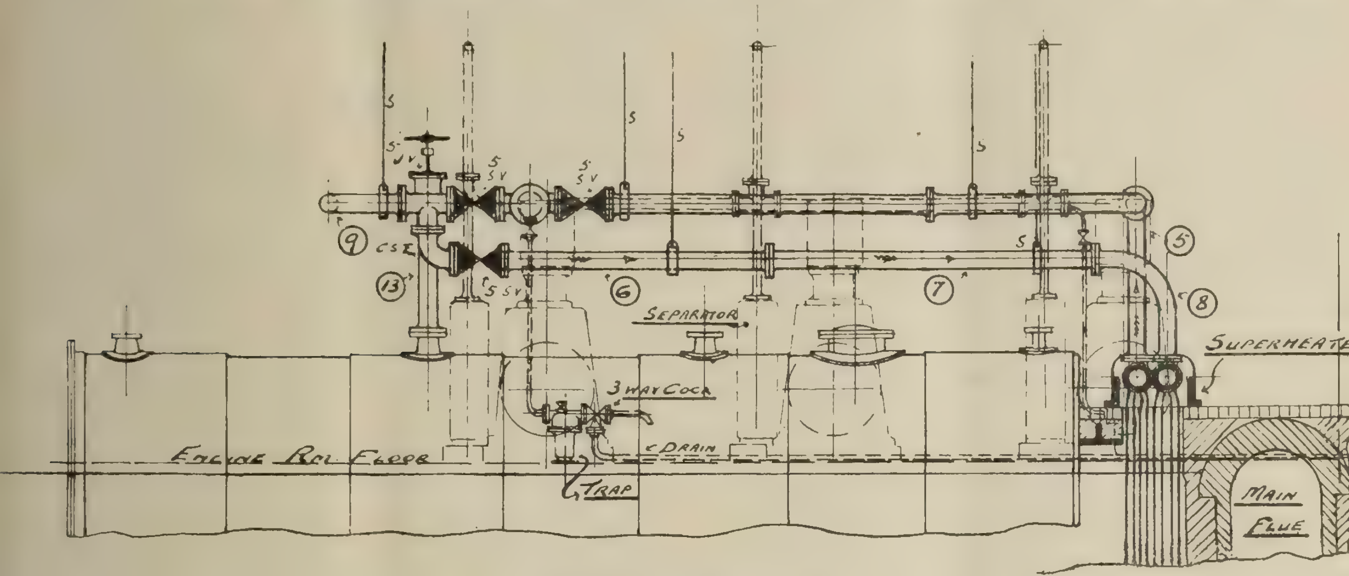
Water-power in Tasmania.—The wonderful possibilities of Tasmania for the development of water-power are commented on in *Power*. The island possesses just in its centre, on a high elevation, a lake sufficiently large to provide its industries with all the electrical power that may be needed for some time to come. The basis of the whole system is the Great Lake. With a catchment area of 216 square miles, and a water area of 50 square miles, it forms an ideal foundation for a great hydro-electric enterprise. A dam that has been constructed on the southern outlet of the lake provides for an even depth of 11 ft. above the sill level, and experience has proved that this will be sufficient to guarantee a regular flow of water. Experiments made during the first year of operation have shown that during a year of normal rainfall a total of 70,000 H.P. can easily be obtained from the lake.

Aluminium and its Alloys.—Dr. Rosenhain, in an address on this subject at the British Science Exhibition, said that aluminium alloy was not a German monopoly. A Zeppelin framework had a tensile strength of 25 tons to the square inch, but this is not so good as the combination of lightness with high strength that could be produced in this country. Comparing steel having a tensile strength of 28 tons to the square inch, with pure aluminium of 7 tons strength to the square inch, he said that the length of a vertical bar of steel that could just carry its own weight would be 19,000 ft., and of aluminium 14,000 ft. But with alloy the length of the aluminium bar would be extended to 50,000 ft. In large structures like bridges the weight of the structure was so great that the weight of a train was almost negligible, but the point came where the span could just carry itself; and, in comparison with steel, the light alloys of aluminium could increase the limiting span threefold. There was great expenditure of energy in starting and stopping electric trains, and if the heavy steel parts of locomotives could be replaced by light alloys there would be quicker starting and stopping, and an important saving.

At Warrenpoint, Carlingford Lough, a new yard for the building of ferro-concrete vessels, the only one of its kind in Ireland, has been constructed. Two Belfast firms, Messrs. J. and R. Thompson and Messrs. McLaughlin and Hawey, have joined forces for shipbuilding purposes. A site was acquired consisting of a narrow strip of land, bounded on one side by a railway siding and on the other by the estuary. A deep-water quay, beside which steamers drawing 14 ft. can berth, adjoins the site. The greater portion of this will be used as a fitting-out berth. A crane has been erected, a large fitting shop has been built alongside, and this is to be equipped with modern machine tools for dealing with repairs and fitting out. There are also joiners' shops, a smithy, complete crushing and screening plant, mould lofts, cement stores, concrete mixer house, and a full range of offices. Narrow-gauge rails are laid down all over the yard to facilitate handling of materials. Nine months ago the site was a bleak stretch of barren beach. To-day it finds employment for 400 workers. Orders are on hand for Admiralty barges.

than the other types of dryers, but the depth of body seems to be somewhat shorter. These are minor points, and do not affect the efficiency of the separator.

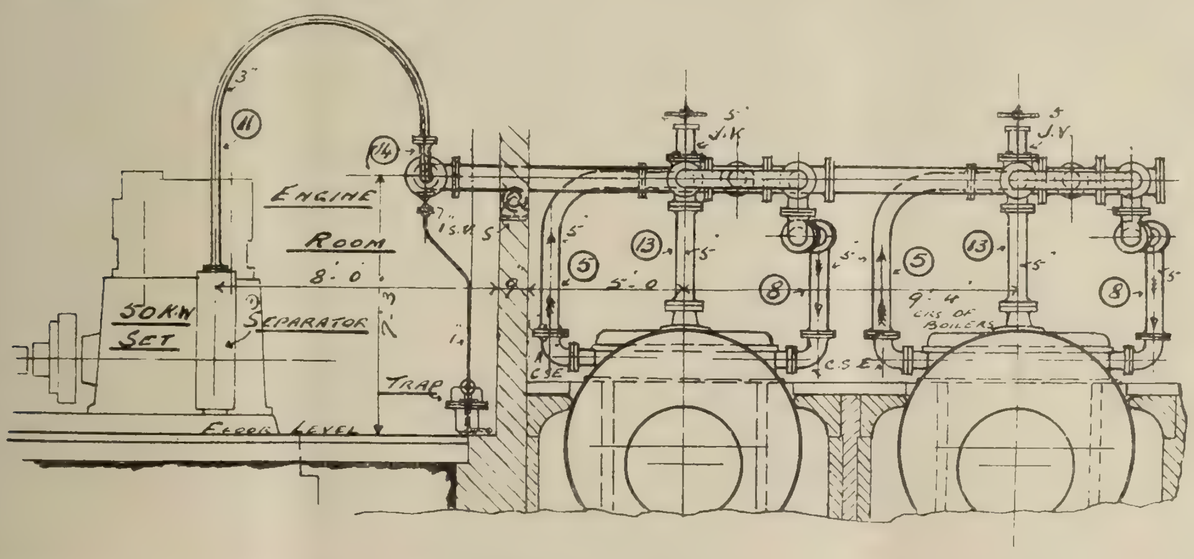
Messrs. Lancaster and Tonge's separator, as shown at Fig. 27, represents a type for cases where a high degree of dryness is desired, though to effect this no internal complications are present. A central vertical pipe A is carried in the main body up which the steam passes to the outlet. The steam, on entering, is caused by means of the deflecting plate indicated, to flow in a descending spiral direction round the central pipe as indicated by the arrow, before rising through it to the outlet. The momentum of any particles of water or solid matter which may be entrained in the steam causes them to be flung radially and downward to the lower part of the receiver, so that only dry steam is passed up the central pipe. The inner surface of the lower part of the dryer body, it will be noticed, is provided with a number of vertical ribs, B, acting not only to carry off the water and dirt separated by the steam, instead of allowing the incoming steam to lick them up again, but to act as a brake on the revolving current of wet steam lying nearest the outside of the receiver, thus arresting its rotation to a certain extent and facilitating the separation of any particles of water which may not have been ejected by centrifugal force, allowing them to drain to bottom of body.



Engineering Lay-out.—Fig. 29.

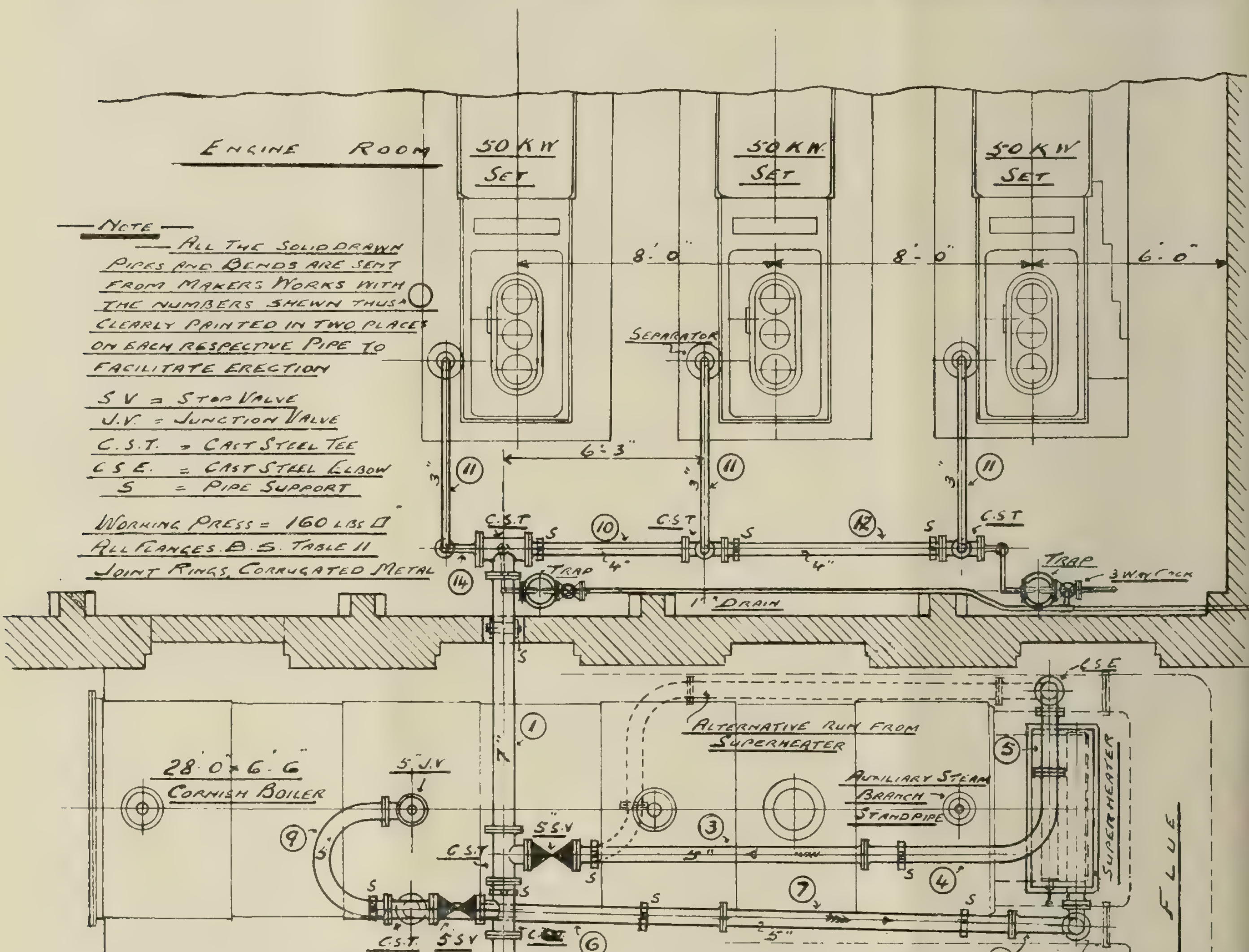
It is good practice to provide mud taps to separators, which should be opened periodically to prevent dirt choking the steam trap connected to the outlet shown, though some makers do not provide for this on their separators.

Fig. 28 represents Messrs. Holden and Brookes' standard separator, and, like the one above described, is suitable where a high degree of dryness is required. As will be seen, baffles are superseded, and from inlet to outlet the steam flows in an unbroken current, the extraction being practically continuous. The steam enters the receiving chamber, passes downwards into an annular space between the outer casing



Engineering Lay-out.—Fig. 30.

and the separating cylinder J, and follows the course indicated by the arrows to the opening L, but before the steam has reached this point it has been divided into two currents, each of which must follow a circular course equal to one-and-a-half times round J, this being caused by the galleries H, H. These galleries also cause the steam to twice reverse its direction. This action in a modified form is again repeated in its passage between the cylinders J and E to the outlet. The water which is collected falls on the galleries H, H, and at these and other points flows down the sides of the casing or cylinders until it reaches the bottom of the dryer. Should any particle of water or dirt retain enough inertia to travel round the first curve, it would not be possible for it to double on itself and get round the second. There seems no possibility in this trap of any water once extracted from the steam being taken up again.



Engineering Lay-Out.—Fig. 31.

Having now dealt with the drainage of steam mains, we will turn our attention to the mains, with their necessary bends, joints, and methods of suspending, etc.

Main Steam-Piping Arrangements.

There are several systems of distribution employed

in power stations for the steam supply. These may be conveniently grouped into four: (1) The simple arrangement; (2) Duplicate system; (3) Ring system; (4) Bye-pass system. The simple system, as the name implies, should be as simple, cheap, and direct as possible, no provision being made for stoppage of the plant should any accident happen to the piping, valves, joints, etc.; the less piping employed on a steam range the better, from an economical standpoint, as the losses due to condensation will be correspondingly low. On the piping of the plant, economy, safety, and reliabilty depend, hence care and forethought should be spent on the general lay-out of the pipes, bends, etc. The arrangement shown at Figs. 29, 30, and 31 represents a simple system of piping, though, perhaps, the addition of two further valves to each boiler to enable the superheaters to be cut out altogether, makes it rather more costly. This provision, however, is not compulsory. It is a convenience and time-saver, more than anything else, as the superheated supply is always wanted at the engines, and in the event of the superheaters being repaired, tubes replaced, etc., the piping can be disconnected at any suitable point, preferably near the main 7 in. pipe, and blanked off. It is a question of first cost. In my opinion, the valves are worth installing. The above example is taken from a plant which has been actually in work for some 15 years, and is a good flexible system. Very little trouble was experienced resulting from leakages, undue strain on mountings, fittings, etc., and the drainage was very efficient.

The Lay-out.

Referring to the lay-out, the plant consists of three 50-kw. sets of electrical generators, the engine being of the quick revolution type, supplied with steam from two 28 ft. by 6 ft. 6 in. Cornish boilers. Two, however, of the units were only used, the second boiler being a stand-by. The steam pressure at junction valves was 160 lb., and the total temperature of steam at engine stop valves about 450 deg. Fah. The piping was solid drawn, with welded-on flanges, tees and elbows in cast steel. No template pipes were allowed for. The 3 in. bend pipes, 11, to engines required slightly opening out at the smithy to come into position. The other pipes came in all right. The superheaters would be capable of being adjusted to accommodate any slight shortage. I have indicated on the plan an alternative run for the supply pipe from superheaters. Though involving two extra bends, perhaps this would be recommended, as it allows the superheaters being quickly removed, if necessary, without disconnecting more than two joints per superheater. This, however, is again only a matter of cost, and as regards efficiency, if anything, is not so good as the run indicated in full lines on account of the slightly increased surface for condensation. The traps are of the bucket type, and it must not be forgotten that the 1 in. piping connecting same to the steam main must be of the same materials as the latter. As will be seen from the side elevation (Fig. 29), a 3-way cock is provided at the discharge of trap, so as to periodically test same by placing a bucket under the short discharge spout shown. This provision should always be made where traps discharge into a closed drain, as without it is not possible to ascertain always whether the traps are doing their work. The range is suspended at the points indicated. It, however, is better practice, where possible, to support the piping from underneath, on account of the vibration tending to cause leaky joints, though this plant was singularly free from any trouble due to this.

(*To be continued.*)

CHIMNEY STACKS.

By JAMES CLAUGHTON.

(*Continued from page 35.*)

Foundations or Sub-structures.

There are various ways of constructing foundations or sub-structures, according to the nature of the earth comprising the site on which it is proposed to lay down the plant. In other than normal cases the

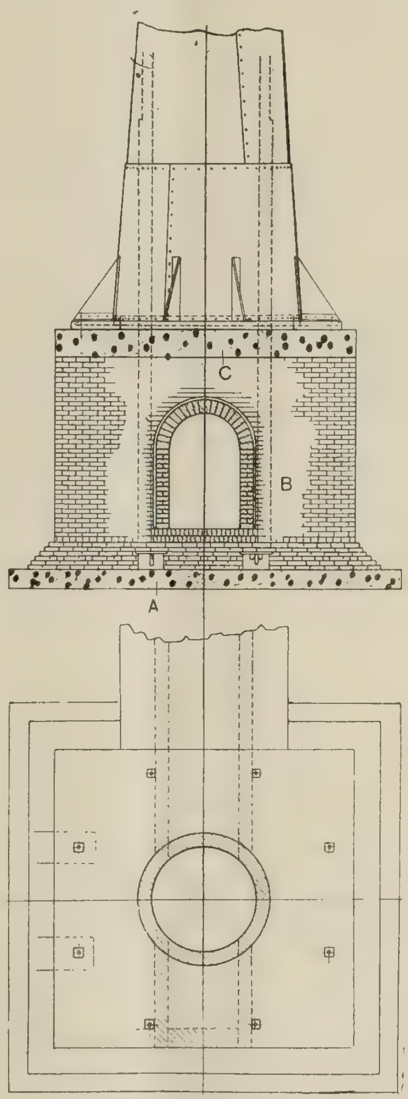


FIG. 1.

actual laying of the sub-structure sometimes proves a very difficult operation, causing engineers considerable anxiety. When the earth is normal and firm, this becomes a comparatively simple matter, inasmuch as it only involves the levelling of the surface, which in the case of chimney stacks is best

carried out by digging a round or square pit, as the design calls for, and filling up with concrete or other suitable material.

When the natural ground is inclined to be unstable and movable, or of a sandy nature, it will generally be found necessary to employ some artificial means of making the ground firm and secure. This is carried out by different ways according to the exact nature of the ground under

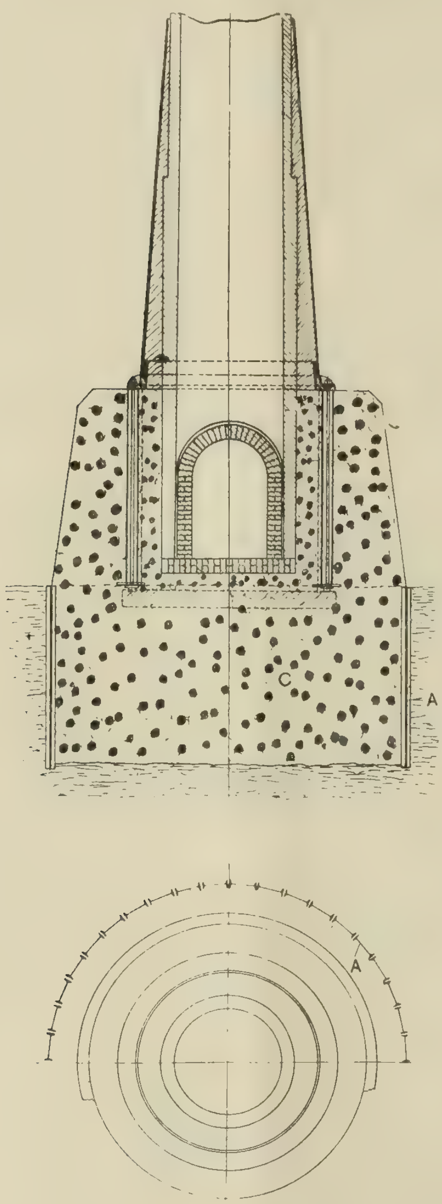


Fig. 2.

consideration. The method ultimately adopted will, of course, depend entirely on the ideas of the consulting engineer in charge.

For tall chimney stacks it is most advisable to have a boring operation made, so as to be able to ascertain exactly the nature of the earth. When this has been done, a suitable and safe foundation can be readily designed.

The compressional or bearing values of sub-soils and strata vary greatly according to their nature and condition. For instance, rock will sustain anything from 18 to 180 tons per square foot, while well compact gravel or coarse sand of considerable thickness and free from water action will withstand from eight to ten tons, and dry, solid clay will easily allow a load of five tons per square foot.

The maximum loading values allowed for sub-soils are very often laid down by the building authorities of the community in which district it is proposed to build. However, the following tables may be taken for a guide:—

SAFE LOADS ON FOUNDATION.

Poor ground	$\frac{1}{4}$ to $\frac{3}{4}$	tons per sq.	foot.
Soft clay, wet sand, etc.	$\frac{3}{4}$ to 1	,,	,,
Normal earth...	$1\frac{1}{4}$ to 2	,,	,,
Hard clay, dry sand	$2\frac{1}{2}$ to $3\frac{1}{2}$	,,	,,
Firm coarse sand and gravel..	$2\frac{3}{4}$ to 4	,,	,,
Hard deep gravel	5 to 6	,,	,,
Concrete (1-2-5)	5 to 8	,,	,,
Rock foundations	12 tons upwards		,,

SAFE LOADS ON BRICKWORK AND MASONRY.

Ordinary brickwork in lime mortar...	2 to 3	tons per sq.	foot.
Ordinary brickwork in cement mortar	3 to 5	,,	,,
Blue brickwork in cement mortar ...	5 to 8	,,	,,
Rubble masonry in lime mortar	3 to $4\frac{1}{2}$	,,	,,
Rubble masonry in cement mortar ...	5 to 7	,,	,,
Coursed rubble	7 to 10	,,	,,
Sandstone	12 to 20	,,	,,
Granite	30 to 40	,,	,,

When the natural ground is firm and of a uniform density throughout, a suitable class of foundation to adopt is that of the type shown in Fig. 1, which consists of a layer of concrete A, 12 inches thick, with a structure of ordinary red brickwork, B, hollowed to form the invert of the flue. To finish, a coping of stone or concrete, C, is laid on the top. On the whole, the above forms a cheap type of substructure, and is in every way well suited for its purpose.

Should the ground be composed of loose movable soil or quicksand, the author would suggest adopting the class of foundation detailed in Fig. 2. This consists of a cylinder built up of steel piling, A, well sunk in the ground and filled up with concrete C, upon which the chimney is ultimately built. The author finds that this type of foundation is specially suitable for sites which are situated at or near the edge of a river, canal, or any other place where there is a possibility of the ground becoming saturated with water.

As previously stated, the actual determination of the size of the necessary foundations required is purely a matter for local consideration. The method to adopt in this connection will readily be seen in the worked-out examples which follow.

As a final note, it ought to be stated that it is advisable to design the foundations well on the heavy side, so that a good factor is allowed, for as previously pointed out, stability of the entire structure is the one-and-all-important item governing its safe and sound construction.

(To be continued.)

In view of the ever-increasing adoption of the system of ball bearings, our readers may be interested to know that, as a result of many requests from different sides, Messrs. Sterns Ltd., of Finsbury Square, London, E.C. 2, have now turned out a Special Ball Bearing Semi-fluid Lubricant, which will be found to overcome all difficulties that have hitherto existed in getting a lubricant which was guaranteed acid-proof, and, at the same time, had sufficient body or substance in it to ensure the necessary film of lubricant, and, at the same time, not be so heavy as to produce a resisting force.

PIONEER ELECTRICAL ENGINEERING.

By F. Ashton.

(*Concluded from page 55.*)

Electric Traction.

The fact that electric traction did not begin to materialise until after the introduction of commercial dynamos is, of course, not to be wondered at, for no hope of success could be entertained so long as primary batteries were relied upon for the propelling power. Nevertheless, history shows that attempts were made to utilise electric motive power long before the advent of the dynamo. Jacobi's motor, for instance, built in 1838, and worked with primary batteries, was employed for propelling a boat on the River Neva. Moreover, even earlier than this (1836), a Mr. Davenport, a blacksmith in Philadelphia, had turning lathes actuated by electricity, and in his determination to go ahead, he published, in 1840, a newspaper, called *The Electro-Magnetic and Mechanics' Intelligencer*, which was printed on a press worked with some sort of electro-magnetic engine. More remarkable still were the accomplishments of Robert Davidson, who, in 1842, built an electric locomotive, which was tested on the Edinburgh and Glasgow Railway, now part of the North British system. This locomotive, which undoubtedly was the first to be propelled by electricity, hauled a weight of six tons at a speed of about four miles per hour, and was worked with a battery composed of forty cells, having iron and zinc plates immersed in dilute sulphuric acid. Needless to say, from a commercial standpoint, the locomotive was quite valueless, but as an historical relic it is of great interest, and gives to Glasgow the distinction of being the first place in the world to test the possibilities of electric traction. It seems that the locomotive made several trips on Scottish railways, but was finally wrecked by jealous employees whilst lying in a car shed at Perth. The first electric railway with current supplied to the train from an insulated rail was shown at an exhibition in Berlin, in 1879, by Werner von Siemens. A locomotive consisting of a three-horse power motor, and mounted on a truck, hauled a train composed of three passengers at a speed of four miles per hour. Two years later, a short electric tramway was put down at Lichterfelde, near Berlin. Next came the Portrush and Bushmills electric railway in Ireland. This railway was opened in 1883, and in the same year, Volk's beach electric railway was put into operation at Brighton. Small electric traction systems of a similar character were also put into operation at Ryde, Isle of Wight, and on Southend pier, but electric traction in this country really began with the opening of the City and South London tube railway, in 1890. This railway, which has the distinction of beng the first deep level electric railway in the world, was originally only 3½ miles long, but it has since been considerably extended. With what followed in the way of railway electrification after the opening of the City and South London line, the writer does not propose to deal, for that would take us beyond the bounds of pioneer electrical engineering. It will suffice to say that railway electrification has since moved at a rapid rate, although much still remains to be done in this direction.

The Great Awakening.

Towards the close of 1882 the possibilities of electric supplies were being widely discussed in engineering circles, but the ideas that prevailed in those days were very different from those which prevail now. It was suggested, for instance, that for the lighting of London there should be a generating station for every quarter of a square mile, a suggestion which in the light of the recently issued report on the proposed National Power Scheme appears little short of ridiculous. Fortunately, this scheme never materialised, although it is well known that electric supply stations are far too numerous, not only in London, but in other parts of the country as well. Of the pioneer workers in this particular field, Mr. Ferranti (now Dr.) did more than anyone else in the way of advocating the generation of electricity on a large scale. The scheme with which Mr. Ferranti finally became connected originated in the electric lighting of the Grosvenor Picture Gallery, London, which ultimately resulted in the formation of the London Electric Supply Corporation, at that time by far the largest and most important of all electric supply undertakings. A station was built at Deptford, six miles from the centre of London, the idea being to generate current under the most advantageous conditions on a site where coal could be obtained cheaply, and where condensing water could be drawn from the River Thames. Altogether the promoters of this scheme displayed distinct courage, for apart from the fact that it was a much larger undertaking than any other working or even proposed, the current was transmitted to sub-stations in the centre of London at a pressure of no less than 10,000 volts, a pressure which in those days was very much greater than those commonly used. The Deptford station had, in the early days, a somewhat chequered career; although it has now emerged successfully from its period of distress and supplies current not only for private lighting and power purposes, but also for working the single-phase electrified lines of the London, Brighton and South Coast Railway. Those who were connected with this scheme at the time of its inception can, no doubt, look back upon queer and exciting experiences, for it can well be imagined—having regard to the meagre knowledge then available relative to the design and construction of large high-tension machines—that the performance of the plant occasionally left something to be desired. Some time after the Deptford station started, a short circuit in the Grosvenor Road station set the place on fire and destroyed the plant, whilst later on the London Electric Supply Corporation became short of funds, and ultimately went into the hands of a receiver. This was a great set-back to Mr. Ferranti's plans, for he had designed and actually had under construction a generating set rated at no less than 10,000 horse power, which, owing to the unfortunate financial position in which the Corporation found itself, was never completed. But, despite all trials and troubles, the Deptford station had an enormous influence upon the development of electric supplies in this country, as well as in other parts of the world, for although engineering and financial difficulties were met with, the scheme demonstrated clearly and conclusively that the supply of eleectricity on a large scale was a

thoroughly practicable proposition. No country in the world can boast of better pioneer electrical workers than England, but it is nevertheless a fact that we are not, at the present time, generating our current under the most advantageous conditions, for we have far too many small stations equipped with uneconomical generating sets. What has been done on the banks of the Tyne is common knowledge to readers of *The Industrial Engineer*, and it is by following this example of the economical generation of electricity and by using large generating sets that we shall ultimately emerge triumphantly from the unsatisfactory state into which we have unfortunately drifted.

(*Concluded.*)

THE INSTALLATION AND OPERATION OF STATIC TRANSFORMERS.

By F. Ashton.

(*Continued from page 11.*)

Transformers working on three-phase circuits are not always connected up in the same manner on the high and low-tension sides. The primary and secondary windings may, of course, both be connected mesh-fashion or star-fashion, but the primaries may also be connected in mesh and the secondaries in star, and *vice versa*. In Fig. 12, for example, three transformers are shown with their primaries mesh connected and their secondaries star connected; hence the pressure between the ends of any primary winding is the same as that between any two primary wires, but the current in each primary winding is only 57.7 per cent of the main current. On the secondary side of the transformers, however, the conditions are reversed; that is to say, the voltage between the ends of any low-tension winding is only 57.7 per cent of the main secondary voltage, but the current in the windings is the same as that in the secondary wires. This method of connecting-up transformers to three-phase circuits is frequently used, it being particularly advantageous on account

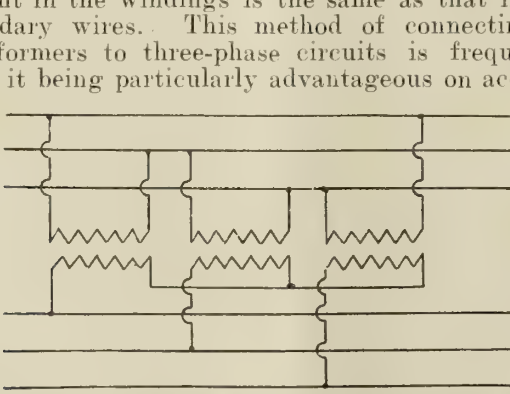


Fig. 12.—Transformers with Primaries Connected in Mesh and Secondaries in Star.

of the fact that a fourth wire may be taken from the neutral point on the low-tension side, thus giving a four-wire distribution system. It is evident that with the secondaries connected star-fashion, the number of secondary turns will be only 58 per cent of the number of turns necessary for mesh-connected windings, but for a given output the cross-section of the conductors must be correspondingly greater. When a tapping is brought out from the neutral point of the star-connected secondaries, so as to give a four-wire distribution system, as shown in Fig. 13, single-phase current may be obtained on the secondary side by making a connection with any one of the three-line wires and the neutral wire, whilst three-phase current can be drawn from the three-line wires in the ordinary way at a voltage $\sqrt{3}$ or 1.73 times greater than the single-phase voltage. The system may be used where it is desired to operate motors at one voltage and lights at another and lower

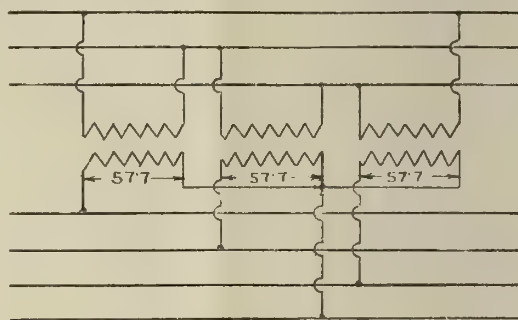


Fig. 13.—Transformers with a Neutral Tapping on the Secondary Side.

voltage, but it obviously involves the use of more copper than an ordinary three-phase system, supplying only three-phase current.

Phase Transformation.

There are many points to be considered in connection with the operation of transformers, but at this stage it may be advisable to deal with the question of phase transformation. In practice, circumstances sometimes make it desirable to alter the nature of a supply; not only with regard to voltage or periodicity, but in respect to the number of phases. It may, for instance, be necessary to change from two-phase to three-phase or *vice versa*, or from three-phase to six-phase, as when feeding six-phase rotary converters. The first problem to be considered in this connection is that of changing poly-phase current into single-phase current. Many attempts have been made to do this with the aid of static transformers, but practical experience and theoretical considerations show that such a transformation is physically impossible, without bringing into play a revolving device which can store energy at a certain part of an alternation and deliver it again at another time. The reason for this is that a single-phase load represents power which is pulsating or varying periodically from zero to a maximum, whilst a balanced polyphase load represents continuous power of constant value. Obviously it is not practicable to transform from continuous power to pulsating power or *vice versa* without some means of storing and restoring power, from which it follows that single-phase power cannot be transformed into polyphase power or *vice versa*, with the aid of static transformers. Nevertheless many attempts have been made to employ transformers for this purpose, and in some cases it has appeared that the scheme has worked satisfactorily, for the three phases have been equally loaded with current. But balanced currents in this case do not represent balanced power loads, nor do they, as a rule, mean less total loss in the generator windings, for the equality of current in the different phases is obtained simply by the presence of out-of-phase currents, part of them usually

being lagging currents and part leading currents, and the resultant reactions and unbalancing effects of these leading and lagging currents have precisely the same effect upon the generating system as a single-phase load taken directly from the three-phase generator. It therefore follows that whenever it is necessary to transform three-phase current into single-phase current, or *vice versa*, use must be made of a revolving machine, such as a motor generator. With a machine of this sort, consisting of a three-phase motor coupled to a single-phase generator, the electrical energy put into the motor is of course transformed into mechanical energy, and then again converted into electrical energy in the generator. The single-phase and poly-phase currents are obviously quite independent of one another, and as far as operation is concerned the method is ideal. On the other hand, the double transformation of power involves an appreciable loss in efficiency, but when it is desired to alter the frequency of the current as well as the number of phases, without disturbing the poly-phase load conditions, then a motor generator must be employed. If, however, it is desired to convert poly-phase current into direct current, then it is more economical to use a rotary converter. Withing recent years this problem of obtaining single-phase currents from polyphase systems has called for more attention than hitherto because of the demand for single-phase current for electric furnaces, electric fusing applications, and for railway service. As nearly all large power stations generate three-phase current, the problem of delivering single-phase power from such systems, without unduly disturbing the phase relations and voltage conditions, has become an important one. Where the power factor of the load is low, as, for instance, in the case of some electric furnaces, a great advantage of employing a motor generator is that the power factors of the supply system and the load are absolutely independent of each other.

A New Method of Converting Polyphase Current into Singe-phase Current.

When it is desired to convert poly-phase current into single-phase current without altering the periodicity part of the single-phase load can be delivered directly from one phase of the three-phase system, whilst the other part of the load can be taken from one of the other phases, and re-transformed in phase by rotating apparatus to that of the single-phase load. Strictly speaking, this method of phase transformation, which has only been put to the test of practical application within recent years, has little connection with the installation and operation of static transformers, but, on the other hand, it would scarcely be right to deal with the question of phase transformation without considering it. The system is being used, with marked success, on certain electric railways in America, and has been adopted with the object of enabling locomotives, fitted with three-phase induction motors, to run on lines supplied with single-phase current. The advantage of the system is that, although there is only one overhead conductor, from which the single-phase current is collected, the motors are supplied with three-phase current. The motors are therefore devoid of commutators, and are more robust than the machines used on ordinary single-phase railways. Moreover, when trains are descending gradients the three-phase motors readily act as generators, and generate three-phase current, which is converted into single-phase current and supplied to the overhead trolly-wire. Briefly, the phase transformation is brought about by means of a small rotary machine, not unlike an induction motor. It has two stator windings displaced by 90 electrical degrees, and one of these windings is directly connected across the secondary of the main transformer, and the ends of this secondary winding form two of the leads belonging

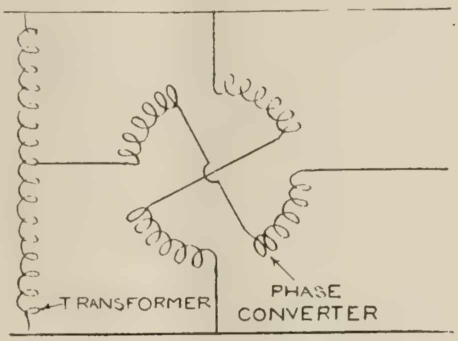


Fig. 14.—A Method of Converting Single-phase Current into Three-phase Current

to the three-phase circuit. (See Fig. 14.) One end of the other stator winding of the phase converter is connected to some intermediate point on the secondary winding of the transformer, and the opposite end of the phase converter winding forms the third wire of the three-phase circuit. When in operation, the rotor of the phase converter naturally revolves, and in order to correct the power factor of the current it is usual to provide the rotor with a winding into which direct current is fed. In these articles, however, attention must be paid more particularly to the possibilities of changing the number of phases with the aid of static transformers, which are frequently used in this connection.

(To be continued.)

AN IMPROVED METHOD OF CONCRETE SHIP CONSTRUCTION.

When constructing concrete vessels in the customary manner, the bottom of the hull cannot be concreted until the reinforcement for the bottom and side walls, the bulkheads, the transverse frames and the keelsons have been assembled and shuttered. This method of procedure causes a good deal of inconvenience and loss of time, especially as wood shavings and chips and débris generally are apt to collect in the series of compartments formed by the moulds for the frames and keelsons. With the object of simplifying construction, an improved method has been patented by Messrs. Mouchel and Partners, Ltd., permitting the bottom of the vessel to be concreted before the assembly of the reinforcement for the remainder of the hull, and also providing for the longitudinal bracing of the frames without the ordinary keelsons, the connection of which with the frames involves an undesirable amount of somewhat complicated work in the way of moulds and otherwise. Special provision is made

for the interlocking and anchorage of the reinforcing bars in the bottom and adjoining parts, and so far as the continuity and monolithic character of the finished hull are concerned, there will be no difference between vessels' construction on the old and new systems. The value of the new method lies in the simplification of work, the facilities given for the more efficient execution of concreting work, and the important saving of time and money that will be effected. This may be taken as one of the many improvements which will undoubtedly be introduced from time to time in concrete ship construction.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.

Mid-Lancs. Branch.

THE following series of lectures will be given in the towns named during the ensuing session, the meetings commencing at 7-15 p.m. :—"Alcohol as a Fuel," by Mr. Adamson; "Electric Traction; by Mr. Barnes, Whit.Ex., A.M.I.E.E.; "Worm and Spiral Gearing," by Mr. Fish, A.M.I.Mech.E.; "Bearings and Lubrication," by Mr. Vickers, A.M.I.M.E.; and "Thick Cylinders and Press Fits," by Mr. Youngmark.

Bolton and District.—Dec. 13th, Mr. Fish; Feb. 14th, Mr. Barnes; March 14th, Mr. Adamson; and April 11th, Mr. Youngmark.

Preston and District.—Jan. 8th, Mr. Youngmark; March 5th, Mr. Fish.

Rochdale and District.—Dec. 11th, Mr. Vickers; Jan. 24th, Mr. Barnes; Feb. 21st, Mr. Fish; March 21st. Mr. Adamson.

Any member who happens to be in the towns named will be admitted on presentation of membership card. The Secretary of this branch has a number of lantern slides, including a set of 50 on steam turbines, which may be loaned on application being made to him at 14, Cyril Street, Bolton.

Letters to the Editor.

THE STEAM LOOP.

To the Editor of "The Industrial Engineer."

DEAR SIR,—Your correspondent, Mr. Warhurst, in the issue of November 8th. suggests that the design of steam loop illustrated in Fig. 2 of my article on the above is impracticable, unworkable, his reasons for this apparently being based on the assumption that a steam loop is virtually, and in an operative sense, a syphon. This is certainly not the case. A syphon is a contrivance actuated purely by atmospheric influences, whereas in a steam loop no syphonic action whatever takes place; it being wholly one of a difference of pressure in the respective pipes, and gravity.

But has not your correspondent heard of or seen in operation a steam loop of the "Holly" type, which in effect operates precisely along the lines indicated in the diagrammatic illustration referred to? Or does he know that a "Pratt" return trap will return water from a level which may be as much as 50 ft. below the level of the boiler? What then becomes of the syphon theory?—Yours, etc., F. R. PARSONS.

Exeter, November 19th, 1918.

Publications.

There is a wide field for the improvement in the running of boiler-house plant in this country, and the present coal crisis will no doubt do much towards this end. **Messrs. Brownlee and Green Ltd.,** consulting engineers and technical chemists, of Church Street, Cheetham, Manchester, have published a most interesting article entitled "Coal Saving by the Scientific Control of Steam Boiler Plants." The article gives the complete scientific investigation of the working of 250 steam boiler plants, representing about eight years' continuous work, showing, it is claimed, the average nett working efficiency to be 60 per cent. on a total coal consumption for steam generation of 75 to 100 million tons per annum, and that by adapting scientific methods 75 per cent efficiency can be obtained, representing a national saving of 15 to 20 million tons, or 20 per cent per annum. The tests made are most exhaustive, and complete to the smallest detail, and the author is confident that the 250 boiler plants dealt with in his article are representative of all the boiler plants in this country. The article is most instructive, and should be most beneficial to all those who have steam-raising apparatus under their charge. We congratulate Messrs. Brownlee and Green Ltd., in successfully investigating a problem which has been ignored so long by so large a number of steam users.

Now that building restrictions no longer exist, contracts which have been in abeyance will no doubt be proceeded with as soon as possible. **Messrs. John Wilson Ltd.,** of Dock Road, Birkenhead, manufacturers of lifting machinery, have forwarded catalogues 53 C and 53 W. In the former are illustrated several types of contractors' shunting, dockside pile-driving, and yard locomotive cranes, in capacities from 2 to 25 tons. A special type of permanent-way travelling crane is depicted designed for use on railways, and arranged for coupling up to ordinary rolling stock, and travelling with fast trains. Another notable type is the "Jubilee Excavator," made in sizes varying from 3 to 15 tons lifting capacity, at a 16-ft. radius. These machines revolve in a complete circle, and, it is stated, give the largest output of any steam excavator on the market, dealing successfully with stiffest clay and other hard materials, including ironstone ore and sandstone rock, and having the lowest coal consumption and maintenance costs. The excavator can be speedily detached and the machine used as an ordinary crane. An interesting apparatus, automatically indicating the safe load corresponding to the angle of the jib is described, and is known as the "Henriques Patent Safe Load Indicator." This firm also are extensive manufacturers of electric cranes, overhead travellers, concrete mixers, centrifugal dredging plant, steam pumps, and winding engines, etc. Catalogue 53 W deals with winders and capstans, etc., for marine use, similar apparatus to that described therein being fitted to a large number of leading shipping companies.

The Consolidated Pneumatic Tool Co. Ltd., of Egyptian House, Piccadilly, London, W., in their catalogue, No. 40, illustrate their well-known hammers and drills, as well as several later types of machines dealing with a large range of hammers intended for chipping, caulking, and similar work. Riveting hammers are offered, with several alternatives regarding handles, either with or without means to prevent the piston accidently discharging. Also are shown a large number of Jarrow riveters for use in confined spaces, in sizes varying from 8 in. to 24 in. overall. Pneumatic drills are described in two types, the "Little Giant" Drill with ball bearings, and different ranges of speed, also the "New Giant" fitted with Corliss valves, giving the lowest possible air consumption with high drilling speed. A notable feature is the "Little Giant" close-quarter drill, made in several sizes, the smallest taking $\frac{7}{8}$-in. drill and is $3\frac{5}{8}$ in. in length without drill. A small pneumatic hoist is also described, having a lift of 4 ft. to 5 ft., the load being according to diameter of barrel. It is fitted with a patent regulator safety valve, operating automatically on the failure of the air supply. The firm also manufacture a complete outfit for underwater use, which should find a ready market in the salving operations no doubt about to take place in the near future. It is altogether an interesting little booklet, dimensions and sectional drawings of the various apparatus being in most cases given, also the consumption of air in cubic feet per minute. Separate catalogues are issued for spare parts, air compressors, electric tools, rock drills, and speed recorders (especially designed for use on locomotives and trains).

The W. J. Crouch Co., Incorporated, and Rownson, Drew and Clydesdale, Inc., announce the amalgamation of their respective organisations. All trading and manufacturing operations henceforth will be conducted under the name of ROWNSON, DREW AND CLYDESDALE, INC., with general offices at 68, William Street, New York. The linking of "Crouch Steel" with the century-old traditions of the house of Rownson, Drew and Clydesdale constitutes an ample guarantee of service and the maintenance of highest business standards. All pending orders and contracts on the books of the old firms will be carried out by each of them, irrespective of the change that has taken place.

Patent Applications.

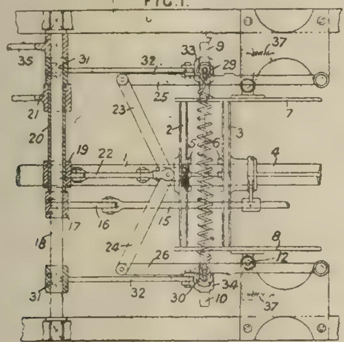
The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

ABSTRACTS OF SPECIFICATIONS.

VARIABLE-SPEED FRICTION GEARING.

117,900.—G. TAYLOR, Cumberland Garage, Middlegate, Penrith, Cumberland. June 8th, 1918. In disc and roller variable-speed and reversing gearing for use on motor-vehicles, etc., an horizontal driving-shaft 1 carries a roller 2 geared to a similar roller 3 sliding on the driven shaft 4 by idle discs 7, 8 rotating on bearings oscillating on vertical axes 12. Driving-pressure is maintained by rollers 9, 10 carried in frames 33, 34 secured on rods sliding in bearings parallel to the shafts 1, 4.

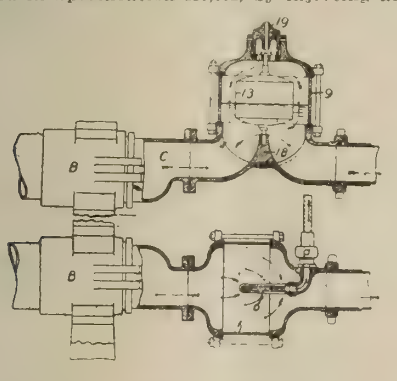
FIG. 1.



The rollers 3, 9, 10 are adjusted to change the speed and at the same time maintain even driving pressure by rotation of a hand-lever 35 secured to a rock-shaft 18 carrying levers 17, 31 connected to the rollers by a link 16 and rod 15 and by links 32, respectively. When clutch parts 5, 6 on the rollers 2, 3 are engaged for high-speed solid drive, a hand-lever 21 is moved to rotate a sleeve 20 carrying a lever 19 connected by a link 22 to toggle links 23, 24 pressing levers 25, 26 against rollers 29, 30 on the frames 33, 34 so that the rollers 9, 10 are withdrawn and the discs 7, 8 are swung aside under the action of springs 37.

AERATING AND COOLING LIQUIDS.

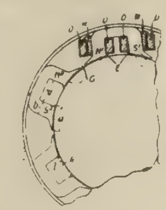
117,911.—P. ROBINSON (trading as R. Morton and Co.), Trent Works, Burton-on-Trent.—May 25th, 1917.—Wort or other liquid is aerated, while being cooled by passage upwards through the enclosed pipes B of a counter-current cooler preferably of the kind described in Specification 115,652, by injecting air, oxygen, or



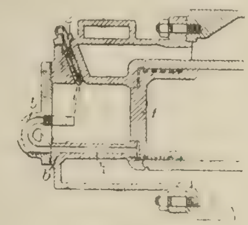
carbon dioxide through nozzles 6, having slots or perforations or formed of wire-gauze, in a chamber through which the liquid entering the cooler flows. The outlet end of the cooler is provided with a snifting chamber containing a float 13 which opens a snifting passage 19 when excess of gas accumulates in the chamber and depresses the level of the liquid. The inlet and outlet of the snifting chamber are separated by a raised wall 18 which may be adjustable in height to separate gas bubbles from the liquid. The inlet chamber and snifting chamber are formed of glass cylinders 1, 9 clamped between end-pieces.

DYNAMO-ELECTRIC MACHINES.

117,934.—CROMPTON & CO. and N. PENSABENE, Arc Works, Chelmsford, Essex.—Aug. 3rd, 1917.—In dynamo-electric machines of the kind wherein the armature reaction is reduced by forming each pole in two parts N1, N2 and S1, S2, etc., separated by a gap G, the weight of the machine is minimised by fitting a separate field coil D upon each half-pole and by maintaining the following proportions in the poles, namely, the length *l* of the poles not to exceed 35 per cent of the pole pitch, the thickness *b* of a half-pole to be between 0.3 and 0.5 of the length *a* of a half-pole arc, the gaps G not to exceed 15 per cent of the pole pitch, and the distance *v* between the main poles measured along the armature periphery to be from 25 to 35 per cent of the pole pitch. The coils D may rest upon projections E on the poles and be retained in position by wedges W, or they may be secured by wedges R inserted in grooves in adjacent poles.



Patent 117,234.



Patent 117,943.

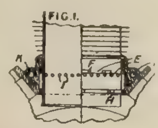
INTERNAL-COMBUSTION ENGINES.

117,943.—H. N. BICKERTON, A. B. BALMFORD, and NATIONAL GAS ENGINE CO., Wellington Works, Ashton-under-Lyne, Lancashire.—Aug. 8th, 1917.—In an internal-combustion engine in which liquid fuel is sprayed through a nozzle *e* into a water-cooled combustion space *b* provided with the usual inlet air and exhaust valves, a piston *f*, at the end of the compression stroke, forces a portion of the charge through a passage *k* and an artificially-heated tube *l* into the space *b* in proximity to the nozzle *e*, the temperature produced being high enough to cause combustion. The artificial heat need only be applied during starting.

INTERNAL-COMBUSTION ENGINES.

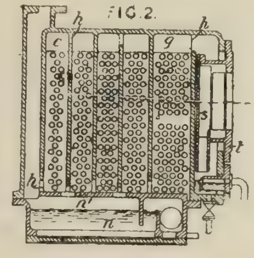
117,971.—B. D. SCOTT, Millers Dale, Urban Road, Sale, Cheshire.—Aug. 21st, 1917.—In a radial multi-cylinder engine, teeth F and recesses E are formed on the cylinders and corresponding recesses and teeth on the crank case, so that the cylinders can be inserted or withdrawn on bringing the teeth and recesses into register. The crank case is in two halves held together by bolts, which engage holes K and are loosened when inserting the cylinders. The cylinders have narrow centring teeth H, which pass through the recesses in the crank case when the cylinder is withdrawn, and which do not obstruct the flow of gas or air from the crank case to holes I in the cylinder.

FIG. 1.



Patent 117,971.

FIG. 2.



Patent 117,972.

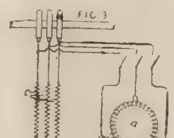
STEAM-CONDENSERS.

117,972.—CONTRAFLO CONDENSER & KINETIC AIR PUMP CO and C. F. HIGGINS, 3, Central Buildings, Westminster.—Aug. 21st, 1917. A surface condenser divided into a series of compartments *c*, *g* by partitions having ports *h* so arranged that the steam takes a zig-zag course is provided with a removable hot-well *n*, the top *n*1 of which forms the bottom of the condenser compartments. Oil and water in the exhaust steam are deposited on a ribbed plate *s* attached to the removable inlet cover *t*. The first condensing compartment *g* contains two groups of tubes and is made larger than the other compartments so as to offer less resistance to the flow of steam. The condensing water may flow through the groups of tubes on the first condensing compartment and through the second and third compartments either in series or in parallel.

DYNAMO-ELECTRIC MACHINES.

117,986.—BRITISH THOMSON-HOUSTON CO., 83, Cannon Street, London, and N. SHUTTLEWORTH, Whinburn, Bilton, Rugby. Aug. 30th,

FIG. 3.

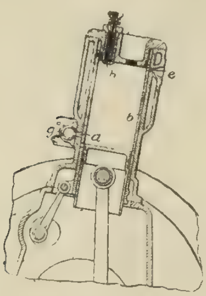


1917.—Resistances *c* are connected in parallel with the commutating phase-advancer *a* of an induction motor (not shown), enabling a smaller phase advancer to be used and the speed of the main motor to be regulated.

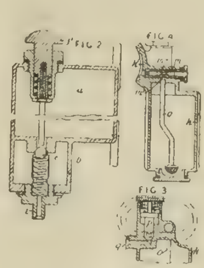
INTERNAL-COMBUSTION ENGINES.

117,978.—B. D. SCOTT, 53, Moreton Avenue, Stretford, Manchester, and W. H. TATE, 7, Westbourne Grove, Sale, Cheshire.—Aug. 28th, 1917.—In a four-stroke-cycle engine having a reciprocating sleeve

valve b which controls exhaust ports e and terminal air admission ports d, fuel is admitted during the outstroke of the piston, and prior to the opening of the air inlet ports, through an injector h. A throttle valve g controls the cylinder port d. According to the Provisional Specification, the exhaust ports remain open during the first portion of the suction stroke for the admission of air. When the air supply is cut off, a partial vacuum is created in the cylinder and combustible mixture is admitted through terminal inlet ports at the end of the stroke. A rotary valve or one having a combined rotary and oscillating movement may be used.



Patent 117,978.



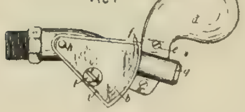
Patent 117,988.

INTERNAL-COMBUSTION ENGINES.

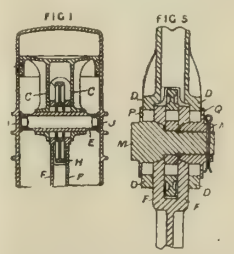
117,988.—E. DOBSON, Foster Engineering Co., Morden Road, Wimbledon, London.—Sept. 6th, 1917.—A spraying device for starting the engine is supplied with fuel from a tank a fitted with a measuring-chamber b, Fig. 2, to which fuel is admitted by a self-closing valve e, opened by depressing a rod $j1$. The spraying-device, Figs. 3 and 4, has fuel and air ducts $m1$, m at right-angles, the fuel duct being supplied form a reservoir k larger than the chamber b, by a pipe o and an annular groove $m2$. The reservoir k has an inlet $q2$ connected to the outlet i of the chamber b, communication being cut off by a suction-actuated valve p except when the engine piston is reciprocated. The device has a flanged head $k1$ secured to the induction pipe, and may be supplied with air under pressure as described in Specification 114,866.

VALVES.

117,992.—A. R. TRAFFORD, 14, The Parade, Felixstowe, Suffolk.—Sept. 11th, 1917.—A rotary cylindrical valve of the type provided with an external segmental valve member closed automatically by a weight has the actuating handle extended outwardly and upwardly to provide the weight and has means for locking the valve in the closed position. The valve member f is pressed toward the seat b by a spring arranged in a recess g formed between a pair of similar but oppositely-handed members i pivoted to the casing at h. The members i are joined together by screws e and are shaped at d to form the closing weight. The side members and the lower part of the casing are slotted to receive the hasp of a padlock or a cross pin l adapted to be secured by a padlock.



Patent 117,992.



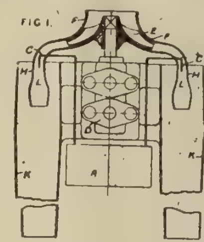
Patent 118,043.

PISTON-ROD GUIDES.

118,043.—J. W. DRAPER, 1, Appleton Gate, Newark-on-Trent.—Dec. 7th, 1917.—The piston-rod of an internal-combustion or steam engine, a pump, or compressor carries a guide-roller engaging the cylinder walls. In the arrangement shown in Fig. 1, the guide-roller H is mounted in a fork F on the connecting-rod. The piston-rod in the form of webs C formed integral with the piston carries the gudgeon pin E, which may be secured by split pins and may be plugged by caps J, engaging the cylinder walls. In a modification, roller bearings are inserted between the pin E and the bearings in the webs C. In the form shown in Fig. 5, the gudgeon pin is formed with a coned head M engaging a coned hole in one of the forks F, a coned nut N engaging a hole in the other forks. Flanges P, Q retain roller bearings. In a further modification, the head M and nut N engage coned holes in the bosses D.

AERONAUTICS; TURBINES.

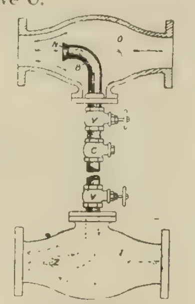
118,123.—H. S. HARRIS, Buckland House, Esher, Surrey.—Aug. 16th, 1917.—A motor producing a gaseous stream for propelling aircraft, vessels, or vehicles by direct reaction, or for driving a turbine, comprises a combustion chamber from which the combustion products issue in the form of a non-expanding stream into an open-ended discharging-tube so that air is drawn in as the stream cools to augment the mass of the stream. Petrol, paraffin, or coal dust may be used as fuel. Fig. 1 shows two petrol jets C supplied from a tank A and arranged in tubular portions H of a fan casing F. The fan E is driven by a small petrol motor D and delivers air at low pressure to combustion chambers L which are enlarged to permit expansion of the combustion products, the ends of the chambers being contracted to increase the velocity of the jets. Rearwardly tapering tubes K open at both ends surround the chambers L. Additional air may be introduced at several points along the tubes K. A series of nozzles or burners may be used in any convenient arrangement, or one or more nozzles may discharge into a single tube of large cross-section which may accommodate the pilot, tank, and engine D at its forward end. Instead of supplying air for combustion from a fan,



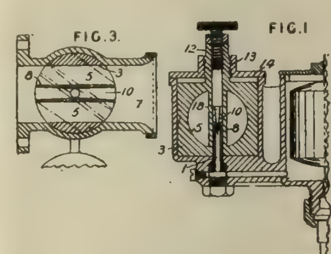
it may be supplied through a collector during forward motion. The air current may induce petrol into the burner, or vice versa. For starting the engine, a fan may be provided in the tube for drawing in air and petrol, and the discharging end partially closed by a valve. A fan driven by the stream in the tube K may also drive the fan E. The tube or tubes K may be angularly movable for steering purposes. The tube or tubes K may be reversed for retarding the speed of the aircraft when landing, or the rear end may be temporarily closed so that gas is discharged from the front end.

HEATING BOILER FEED-WATER.

118,066.—F. GLEAVE, 27, Turf Lane, Hollinwood, and J. R. STUBLEY, 17, Coronation Street, Oldham, both in Lancashire.—March 13th, 1918. To diminish the deterioration of economiser pipes due to great differences of temperature between the incoming feed-water in the pipes and the flue gases, the temperature of the entering feed-water is increased by drawing off hot water from the economiser outlet O through a pipe B opening so as to face the flow of the outgoing water and discharging it into the inlet I in the direction of flow of the incoming water. The inlet end N of the pipe is funnel shaped, and the outlet end Z is contracted to form a nozzle. The pipe is fitted with stop valves V and a check valve C.



Patent 118,066.



Patent 118,070.

INTERNAL-COMBUSTION ENGINES.

118,070.—W. ALLAN, 78, Bayswater Road, West Jesmond, Newcastle-on-Tyne.—March 27th, 1918.—The rotary throttle valve 3 of a spray carburettor is co-axial with the fuel nozzle 1, and has a stem 12 screwed at 13 into the cover 14 so that, as the throttle is rotated, it is moved axially, and the needle valve 18 which is adjustably carried by it varies the outlet opening of the nozzle. The valve bore is divided by a vertical partition 8 into a main air passage 5, and a pilot passage 10 which alone is in action when the valve is in the closed position indicated by broken lines in Fig. 3. Air enters at 7.

Queries and Replies.

WE shall at all times be pleased to help our readers out of their difficulties to the best of our power, and invite them to make use of this column for that purpose.

L. & Y. (Horwich).—The address you require is the Powdered Fuel Plant Company Limited, 47, Victoria Street, Westminster, London, S.W.1.

H. S. (Hollinwood).—The Library Press Limited, 26, Portugal Street Buildings, London, W.C.2, publish a book entitled "Factory Administration and Accounts," which will be of service to you. They publish a booklet (W.4), which will be sent free on receipt of a post-card.

—— THE ——

Industrial Engineer.

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CONTENTS.

EDITORIAL.

THE IMPORTANCE OF INDUSTRY.

A GREAT deal has been published first and last upon the importance of business: the romance of commerce, as it has been termed, has been dealt with by able pens. Ruskin paid special honour to the merchant who was the source through which the community obtained their goods; the term merchant adventurer has an ancient and honourable status. Again and again the general public are invited to consider trade and the supply of their wants as specially meritorious. This is all very proper—in suitable connections it is first-class advertising; the pity is that the favour invoked should bulk so largely as the monopoly of the storekeeper. Large concerns who buy and sell are quoted as instances of the importance of trade to the community. What never seems to be emphasised is the importance of industry. The final term in the series doubtless deserves credit for activity; it certainly does get prominence, as well as substantial profit, yet what about the preceding stages whereby the goods are made which trade markets. There is some ground for suspicion that there is too much protest existing to raise the status of retail trade, and too little attention paid to the foundation upon which such trade exists, namely, the goods without which the trade could not be done. The effect upon the reader is one of justification and an attitude of—some people's motives may not be strictly honest, but we are different. It is taken for granted that the small esteem in which the shopkeeper was held a century ago, has much to do with the present-day chorus of self-appraisal. The public have to be educated into the belief that the tradesman is honest. Virtues as a rule are discovered; they do not blazon themselves articularly, as the man who protests himself honest is apt for that reason to be suspected.

Industry and trade, although interdependent, are not identical, and while the exchange of commodities has merit, the importance of the production of commodities is vastly greater and more fundamental than their transfer to satisfy need.

Ask any manufacturer who gets the greater profit, the maker or the dealer, and who shoulders the greater responsibility and worry, and the answer which cannot be disputed is immediate. Industry is vital, trade is secondary; first-rate goods present little difficulty in disposal; honest workmanship has been respected since the dawn of time, even where worst paid.

The romance of history dates back to prehistoric times, and has been a continuous evolution growing more and more complex, representing as it does the entire real achievement of mankind. Trade, commerce, exchange, finance, are machinery; industry is creative, progressive—all wealth springs from toil of hand or brain. The meanest industrial unit is more essential than the prosperous share juggler, whose part of the programme has been by no means above question. It is impossible to create an oil boom or rubber market unless oil and rubber were first won by industry. Manufacture in its modern sense is the outcome of countless unrecorded mechanical brains who very rarely received more than the most moderate reward.

The pioneer of improvement, destined to fill innumerable pockets, very rarely holds the world to ransom—that is the achievement of trade and commerce—the artificial raising of price for common necessities. There is romance in a highwayman, but he is not an element that society as a whole can

endorse; they suffer him for a period, and then put him under restraint.

The brain power essential to industry is vital to the well-being and comfort of the universe, and there may come a time when the need for artificial credit and bogus dealings will collapse, and a better system take its place.

There is no small cunning in industry; tangible results in economic terms must be daily won: nothing without labour as its motto, and its gains, such as they are, in essentials, are clean. No one is the poorer and all are wealthier because of the production of articles of utility, and the cost paid to produce is never excessive; it is the after-costs which can be so described.

The wonder and marvel of modern times is not the romance of trade, but the romance, and for that matter the necessity, of industry. It lays the world under tribute for its raw materials, and supplies the world when the inert has been made up into the active. The struggle for the possession of raw material and the further competition for disposal in terms of international rivalry have made modern politics and diplomacy industrial in trend. Trade is valueless; without industry it is the final term, not the whole equation; the failure or default of industry lays trade bankrupt. Without stock to sell and prospect of renewals, the shopkeeper puts up the shutters and closes down. The relative dependence is clear.

For this reason increasing attention is being paid to industrial conditions; half the current expressions are in effect industrial. Its importance has never been so realised as now, for upon the well-being of industry and its peaceful enterprise, and the co-operation of all its members, the contentment and solvency of the modern State rests. This, in turn, places a responsibility upon the smallest unit; he is of national importance, never more so, and the cultivation of his individual goodwill is the task to which all thinking minds are bent. There being no superfluity, but a lack, he is receiving unwonted attention, and the industrial situation and its well-being is paramount.

Let us give trade its due; it is secondary, but shares the responsibility. The big retail store has its uses, as commerce, finance, and trade have theirs; but manufacture and industry as a whole scarcely realise their dominance, for it is here and nowhere else that the real factor of enterprise counts for most.

THE AUSTRIAN MACHINE INDUSTRY.

Throughout the war very heavy demands were made upon the Austrian machine industry, as many machines, engines, and plant, hitherto obtained from abroad, had to be produced at home, all import facilities having been reduced to the minimum. At first considerable prejudice against home industry had to be overcome, but, at the present time, consumers have learnt that Austrian goods, and more especially agricultural machinery, are quite as good as the slightly cheaper farm implements and plant hitherto obtained from England and America. At least, this is what the Austrian report says, but, perchance, it is largely a question of "sour grapes." Other branches have also been able to develop considerably, due to the elimination of foreign competition. During the first years of the war Germany also assisted Austria largely in the supply of machinery, until the home industry had time to turn round and face the new situation. Prior to the war, Austria's output of machinery was valued at 500,000 crowns per annum; during 1913, the last year of peace, the imports and exports of machinery into Austria (excluding Hungary) were as follows:—

	Exports.		Imports.
	Value in thousands of Crowns.		
Machinery and apparatus (except electric)	92.0	...	100.0
Electrical machinery and apparatus	34.0	..	32.0
Vehicles	20.0	..	34.0
Total	146.0	...	166.0

Hence the total exports exceeded the imports by K 20,000, but this does not mean to say that the country was independent of foreign competition. Whereas the imports included chiefly German machinery, besides large quantities from England and America,, and also motor cars from France and Italy, the exports went principally to Hungary and foreign countries (oriental markets). Every endeavour is now to be made to render English, American, French, and Italian importation impossible, a matter which should give pause to those Bolshevists and pacifists in this country who have such kindly feelings towards our enemies. Now that peace reigns again, Austrian machine builders and engine works are taking special steps to secure all home trade. During the war automobile firms especially have greatly increased their plant and works in general, and their present output is many times greater than it was in the "piping times of peace." Now that the war is over, the Oesterreichischer Waffenfabriks-Gesselschaft (floated during the war) at Steyr will commence the construction of motor vehicles in series; parts and accessories are also being taken up by new firms, as for instance by the "Freistaedter Stahl- und Eisenwerke A.G.," which has taken up the construction of motor-car chassis. Special attention is being devoted to the construction of locomotives, cars and trucks, and some large works are being erected, amongst others a very large locomotive factory by the Skodawerken, and many large engine repairing shops are also being opened. Every endeavour is to be made to increase the exportation of Austrian agricultural machinery, and several firms have successfully taken up the construction of motor ploughs. Whether all these plans will be realised remains to be seen; meantime they are crippled considerably by the scarcity of coal. Anyhow, Austria is a conquered country, and it is up to us to see that these people, now "our good friends," do not win a commercial victory to replace the one in the field which they have so deservedly lost.

The fourth meeting of the session of the Institution of Automobile Engineers will be held on Wednesday, 8th January, 1919, at the Royal Society of Arts, John Street, Adelphi, London, W.C.2, at 8 o'clock, when Mr. L. H. Pomeroy will read a paper on "Influence of Valve Lift and Combustion Chamber Design on Consumption." Cards of invitation to the meeting may be obtained on application to the Secretary of Automobile Engineers, 28, Victoria Street, Westminster, London, S.W.1.

MODERN STEAM TURBINES.

By J. HUMPHREY.

(*Continued from page 73.*)

Mixed-Pressure Turbines and Continuously Running Engines.

If a mixed-pressure turbine be supplied with steam from a continuously-running engine, and the electric generators of the turbine and engine sets are not electrically connected, each set is controlled by its own governor. At all times the engine exhausts into the low-pressure nozzles of the turbine, and the steam which the turbine receives is therefore governed by the engine load. The pipe connecting the two units together, however, is provided with a branch which is coupled up to the condenser, and in this branch a butterfly valve is fitted, which is controlled by the turbine governor. If the amount of exhaust steam coming from the engine is greater than that necessary to cope with the turbine load, the speed of the turbine tends to rise and the turbine governor therefore opens the butterfly valve in the bye-pass leading to the condenser, and consequently the pressure in front of the low-pressure nozzles of the turbine is lowered to a value which is just sufficient to enable the turbine to deal with its load. The back pressure on the engine is also lowered at the same time, and the engine therefore works more economically. Under these conditions the exhaust steam from the engine has two paths open to it, one through the turbine, which is always open, and the other through the bye-pass, which is opened and closed according to the load conditions. Owing to the engine being under-loaded, it may, of course, happen that the steam which it exhausts is insufficient to enable the turbine to deal with its load, and consequently the speed of the turbine will drop, and the governor then admits high-pressure steam to the turbine, so that under all conditions the two sets work satisfactorily. It is necessary, however, to provide an atmospheric relief valve on the low-pressure supply pipe, so that the back pressure of the engine cannot assume a value greater than the pressure which the engine can safely withstand.

The Thomson-Houston Mixed-Pressure Turbine.

Mixed-pressure turbines, like low-pressure turbines, are built on very much the same lines as turbines working with high-pressure steam. A section of a mixed-pressure turbine, built by the British Thomson-Houston Co., is shown in Fig. 69. The high-pressure steam passes into the turbine by way of the main stop valve, to be seen at the top left-hand corner of the drawing(whilst the low-pressure steam enters the flanged opening at the bottom of the casing, and from this opening it passes through the low-pressure nozzles and on to the second running-wheel, and finally through the third wheel and then away to the condenser. High-pressure steam is, of course, only supplied to the machine when the load is heavy, and when this high-pressure steam has done work on the first revolving wheel, it passes into the second stage of the turbine, through the nozzle shown at the top of the diaphragm, where after passing through the rotating buckets, it mixes with the low-pressure steam, it having by this time been expanded down to the same pressure as that in the low-pressure casing. The provision of separate high and low-pressure nozzles in a common stage, as just described, is a predominant feature in the design of the Curtis mixed-pressure turbine. The quantity of low-pressure steam capable of being utilised by the turbine is quite independent of the amount of high-pressure steam supplied to the machine, because the two supplies are not mixed until the high-pressure steam has done work in the high-pressure stage, and consequently any available low-pressure steam cannot be interfered with or displaced by the steam coming direct from the boiler. The governor gear as fitted to a mixed-pressure Curtis turbine was described by the writer some time back, and it is unnecessary to consider this mechanism here.

The Westinghouse Mixed-Pressure Turbine.

A Westinghouse mixed-pressure turbine is shown in Fig. 70, there being, in this particular case, four high-pressure wheels and four low-pressure wheels. The wheels on the left deal with the expansion of the steam, from boiler pressure to atmospheric

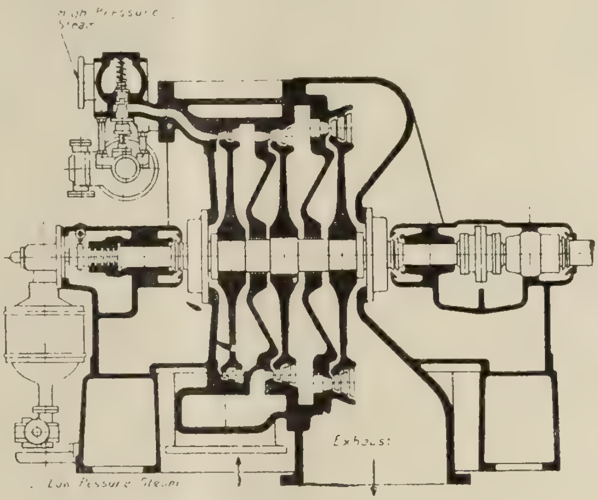

FIG. 69.—A B.T.H. MIXED-PRESSURE TURBINE.

pressure, and those on the right with the expansion from atmospheric pressure to the condenser pressure. Both the governor valves, dealing with the high and low-pressure steam operate perfectly automatically under all conditions of load, the low-pressure steam always being given preference over the high-pressure steam, so that under all conditions the turbine operates with maximum economy. When the valves change over from high-pressure steam to low-pressure steam there is practically no change in the turbine speed, and no additional valve is necessary to prevent a vacuum being formed in the exhaust supply pipe.

Disc and Drum Turbines.

The Westinghouse mixed-pressure turbine is constructed on the Rateau principle, and the British Thomson-Houston turbine on the Curtis principle. The mixed-pressure principle can, however, be applied to other types of turbines, such as reaction turbines, built on similar lines to the ordinary high-pressure Parsons turbine. Messrs. Willans and Robinson, for instance, build mixed-pressure reaction turbines, but the high-pressure steam is usually

dealt with by a Curtis velocity wheel, which takes the place of the reaction blading at the high-pressure end. These so-called "disc and drum" turbines have been built in large numbers by Messrs. Willans and the velocity so acquired is utilised on the velocity wheel. On emerging from this wheel, the steam is then utilised in the reaction blading in the same way as in an ordinary Parsons turbine, but

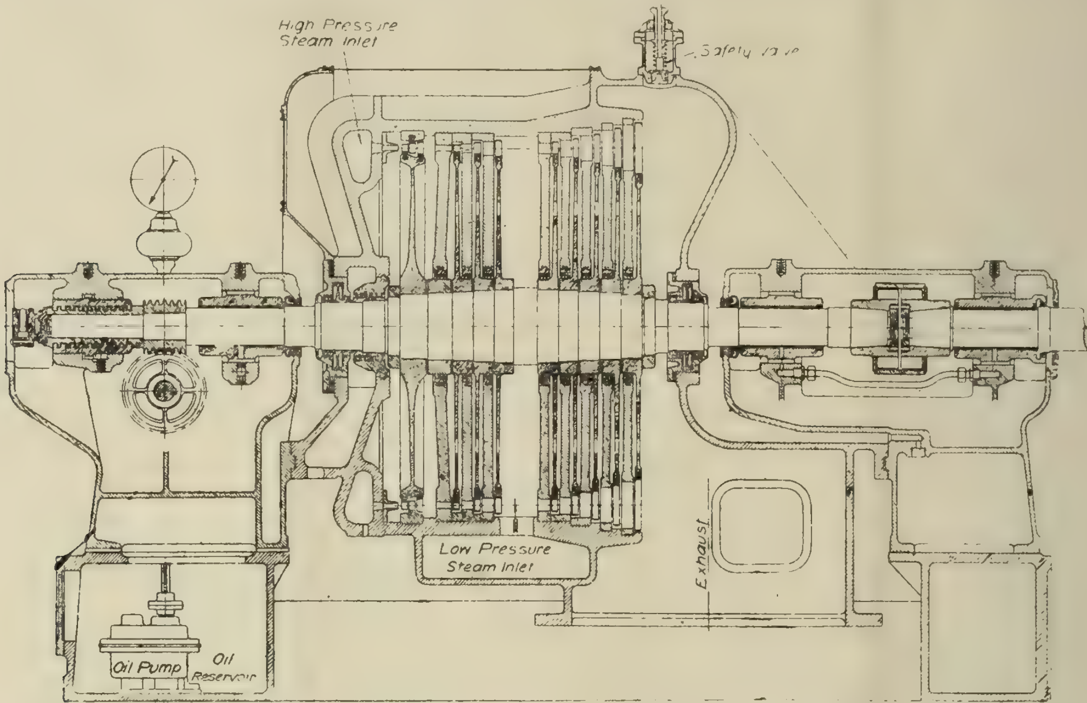

Fig. 70 — A Westinghouse Mixed-Pressure Turbine.

and Robinson, not only for working with high and low-pressure steam, but also for ordinary power house service, where the whole of the steam is taken directly from the boilers. One effect of fitting a velocity wheel in place of the ordinary high-pressure reaction blading, is that the length of the rotor and consequently that of the complete turbine, is materially reduced, as shown in Figs. 71 and 72,

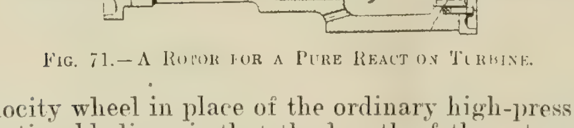

Fig. 71.—A Rotor for a Pure Reaction Turbine.

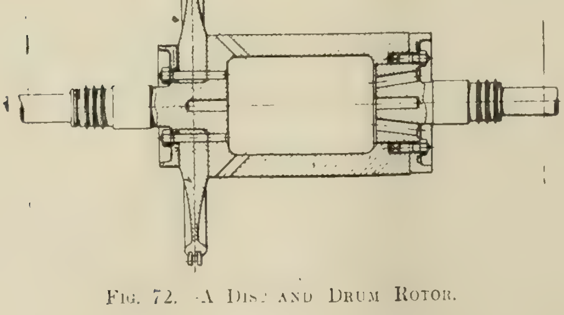

Fig. 72. A Disc and Drum Rotor.

which illustrate an ordinary rotor bladed in the usual manner and a rotor with a velocity wheel fitted at the high-pressure end. The steam in the latter case is first expanded in nozzles as the pressure in this part of the turbine is low, the casing is only subjected to a comparatively low temperature, and troubles arising from distortion of the cylinder are not liable to occur. Furthermore, the radial clearances need not be so fine as those necessary in a turbine having reaction blading at the high-pressure end. The velocity wheel also enables nozzles to be cut out at times of light load, thus eliminating the losses arising from excessive throttling. Some manufacturers claim, however, that for large outputs, at any rate, the efficiency of high-pressure reaction blading is greater than that of the velocity wheel, but a great many disc and drum turbines are now in successful operation, and all builders of reaction turbines supply them when specified.

(To be continued.)

A NEW THEORY OF PLATE SPRINGS.

By David Landau and Percy H. Parr.

(Continued from page 74.)

In 1865, A. Ritter published his "Lehrbuch der Technischen Mechanik," the third edition of which appeared in 1874. This contained, probably, the first text-book treatment of the plate spring. We mention this work as being a sample of the text-book treatment of the subject of the leaf spring which is often given at the present time. Ritter himself seems to have taken out only one special case of Philips's. Ritter applies the Bernouilli-Eulerian theory of beam to a cantilever having a constant thickness in the vertical plane of flexure, and finds

that in a horizontal plane the beam must have the form of an isosceles triangle. He therefore builds a leaf spring formed from a series of leaves obtained by cutting the triangular cantilever, by placing the several plates as indicated by Fig. A. He pointed out the fact that each lamina, at the pointed end, presses on each succeeding lamina with a force P, equal to the load P. The result, naturally, is that each lamina, except the shortest, acts as a cantilever, with a load P at its apex and with a reactive supporting load P at the end of the next shorter lamina. The solution of this problem, is then, of course, quite simple. No proof is offered of this exposition, and we suppose that he assumed Philips's work

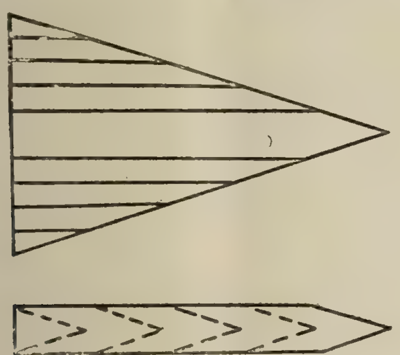

Fig. A.

would answer the case in the affirmative. Ritter added nothing new to the subject, although his work has been copied widely, as he had probably copied Philips's.

Ritter's work is of limited value, though correct, as we shall show later on, in so far as it deals with a special case; its limits have not been pointed out by any writer since his time, with possibly the one exception—Henderson. Henderson, however, only added to Ritter's work by introducing "constants" for "full length" plates: he did not question the accuracy of Ritter's work, nor did he state the limitations of his own applications. A better attempt was made by E. F. Morrison, although Marchesseau indicated a knowledge of this same idea in 1909.

Reuleaux, who in 1857 published his "Constructeur," merely expounded a particular case of Philips's; indeed, Reuleaux has too often been credited with originating equations which were the work of Philips.

As late as 1877, Philips's countrymen gave short abstracts of his work for the engineering fraternity, and among the best of these is that of Albert de Fierlant, who seems to have well understood his master. The last work of de Fierlant, published in 1889, is an excellent short exposition of Philips's special case.

No particular work of great importance seems to have been published since 1850, if we except the recent one by Paul Brennier, which treats of some new phases of the problem, and indicates briefly the inadequacy of Philips's treatment of the general subject. The work of Brennier is very interesting and deserves the careful study of the specialist.

Briefly, the foregoing remarks cover the history of the theory of leaf springs up to the present time. And for the reader who is interested in a critical study of the history of the theory of elasticity, we recommend the careful perusal of Todhunter and Pearson's "History of the Theory of Elasticity." Having outlined the work of the previous investigators, we make no apology for now introducing our own researches.

The study of the particular problem with which the present paper is concerned was commenced by us nearly sixteen years ago; the research was carried on intermittently, and some of the fundamental relations to be treated in the next instalment were discovered but a few years ago.

During the last ten years we have searched, often with the assistance of many others, through the technical literature of the Old and the New Worlds, in order to discover what researches, if any, had previously been made by the earlier mathematicians and engineers which resembled our own. So far we have found but a single paper of importance, that of the famous French mathematical engineer, M. Philips, who, as mentioned in our historical résumé, made a study of the leaf spring initiated on lines akin to our own; his theses, however, gave the mathematical relations in such complex form as to be of but slight use to the engineer and designer. The theory of Philips was not developed to an extent and direction which is in any way comparable with our own researches.

"The prevailing and generally accepted hypothesis on which is based the so-called 'scientific' design of plate springs is only a slight modification of the most elementary concepts and analyses of the early teachers of theoretical mechanics." We shall show that their hypotheses are totally inadequate to explain the complete phenomena of leaf-spring action, and that, without the complete analysis,

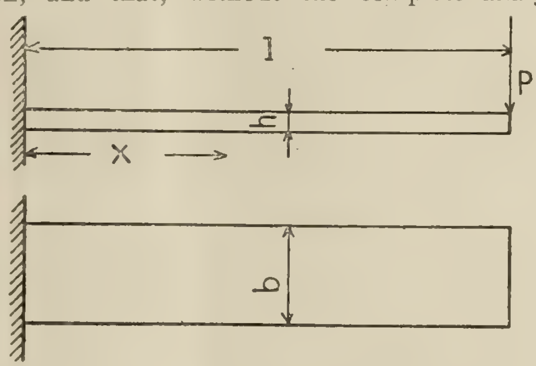

Fig. 1.

which our theory enables us to make, no true scientific leaf-spring design is possible.

The application of the results of our investigation to practice has resulted in springs having an endurance, or life, far greater than usually obtained, and our springs have been a revelation even to those skilled in the art of spring making; in fact, on more than one occasion we have been charged with obtaining the enormous endurance shown by springs designed in accordance with our theory by some mysterious heat applications during the thermal treatment.

In order to lead to a complete understanding of our theory of the leaf spring it seems best to explain first, in as elementary a manner as possible, the pre-

vailing commonly accepted theory of to-day. Our exposition may be somewhat different from some of those given in the text-books on applied mechanics, but the essentials and the results are the same.

Consider a single leaf as shown in Fig. 1, having a length l, a single thickness h, and a constant width b; fixed at one end, and subjected to a load P at the other end. Under these conditions the plate will deflect a distance, say d, as shown in Fig. 2. Of course, we assume in this exposition that any leaf spring may be considered as a beam encastre at one end and loaded at the other, as is the case with a cantilever spring; other springs (such as semi-elliptic springs) may, if desired, be considered as beams supported at the ends and loaded at the centre; the final

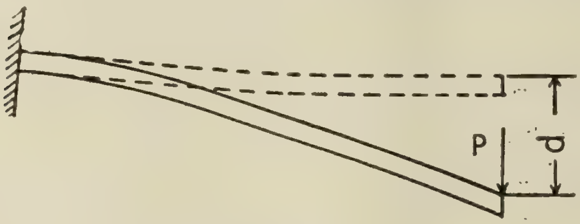

Fig. 2.

result, however, is exactly the same as if they are considered as two cantilevers joined at the points of encastrèment. It suffices, therefore, to consider the case of the cantilever.

Suppose, now, that we arrange some suitable mechanism which shall vibrate this simple, one-leaf spring through the distance d such a number of times as shall cause it to break. Clearly, the fracture will occur at the point of fixation, for the bending moment, which is evidently P $(l—x)$, there attains its maximum value Pl; and, as the section of the leaf is uniform, the stress is a maximum at the same section as the bending moment.

(To be continued.)

INSTALLING OF ELECTRICAL MACHINERY.

By Francis Hancock.

Many engineers will find the following very useful. It often falls to the lot of works engineers to instal their own dynamos and motors, and every attention must be paid to this class of work. When the machinery is to hand it is not always convenient to erect it at once, so, after inspecting the gear, to make sure it is in proper order, it should be packed away in a dry place till wanted. Care should be taken to place the case containing the machinery on battens. This will be found useful in several ways:—

1. It will be found quite easy to pass ropes under the case for lifting.

2. It will protect the machinery from dampness from the ground.

A lot of trouble is caused by allowing the cases to remain on the ground. The following faults are likely to occur, viz.:—

1. Lowering of the insulating resistance of the field and armature windings, which more often than not means their total re-winding.

2. Partial short-circuiting of the field and armature windings, which means the drying-out of the windings in nearly every case.

Machine Foundation.

The foundation is the most essential part, and every care should be taken in its construction. Before starting on the construction, blue prints should be obtained from the machine makers, showing position of holes in bed of machine for holding down bolts, so that holes can be left in the foundation to take them. An excellent foundation is made from the following, viz.:—One part of Portland cement, one part of clean sand, and two parts of rough gravel. Care should be taken not to use too much water when mixing. A new foundation should be allowed to set for about three weeks before the weight of the machine is placed on it. Machines driven by rope or belt are usually set on slide rails; the rails, therefore, are put down and levelled off to take the machine.

Lifting of Machinery.

When lifting whole or parts of dynamos or motors, by means of a crane or sheer legs, a suitable sling must be provided. Portions of machinery that cannot be readily slung are provided with eyebolts for lifting purposes. Magnet frames will generally be found fitted with two eyebolts of sufficient size to lift the top half of the magnet frame if the sling leaves the eyebolts at an angle, but it will be found that, if a suitable spreader be provided, so that the sling leaves the eyebolts vertically, the eyebolts will be capable of lifting the complete magnet frame.

Levelling-up of Machine Bed.

The bed of the machine should be located in its proper position and levelled off by means of iron wedges driven under the bed. The best place to drive the wedges under is under the pedestal and magnet frame. The best way to level the bed off is by using a long straight-edge, one that will reach the whole length of the bed, and a spirit level. It is essential for the bed to be properly levelled off for proper working of end play of the armature, also to ensure that the armature will not knock on one pedestal or the other under working conditions.

The bed of motor or dynamo should always be grouted in. The following will be found to answer quite well, viz.: One part of Portland cement, one part of clean sand. A low dam should be made inside and outside of the bed and floated with the above mixture to a height of about $\frac{1}{4}$ in. above the lower facing of the bed. No weight must be placed on the bed until the grouting is quite set, then the dam can be taken away and the wedges knocked away.

Shim Plates.

With nearly every large machine shim plates are supplied. These shim plates are supplied for the purpose of adjusting the height of the pedestals and magnet frames. It is most essential that the pedestals be finely adjusted for proper working of the bearings. It is usual for makers when dismantling a machine to tie all shim plates in a bundle, and they will be found tied on some part of the machine where they can be readily seen. It will be found that all shim plates are so marked that the fitter will see at once where they belong. They are so marked to minimise the chance of the shim plates being used in the wrong place. Too much trouble cannot be taken in the placing of these shim plates. If wrong shim plates are used it will cause endless trouble.

Fitting up Machines.

Before the bottom half of the magnet frame is placed on the bed, the machined surfaces of both the magnet frame and bed should be thoroughly cleaned, shim plates placed in position, and bottom half of magnet frame placed in position and bolted down.

Before placing the armature in position, the bearing faces of the magnet frame should be cleaned, also the bearing face of the bearings and all burrs and defacements removed by scraping. The lower half of the bearing should then be placed in position and the bearing-face covered with clean lubricating oil and the armature placed in position.

It will be found that on small machines split oil rings are not supplied, but solid rings. It will be necessary to hang the oil ring on the shaft before lowering it into position. Always make quite sure that the oil rings are in their proper position and turn freely when the armature is turned round.

An armature should never be slung by placing the sling under the commutator. It is always best to use a spreader with the sling when lifting the armature into position. The armature winding and commutator lugs should be inspected before placing the top half of the field frame into position. If this is not done and a defect is found in the armature after the top half of the field frame is in position, it will be found a very difficult job to repair any defect. Before placing the top half of the field frame in position, make quite sure that the clearance between the bottom pole-pieces and the armature is correct.

Brush Gear.

For successful working of a dynamo or motor the brush gear must be exactly adjusted. Each row of brushes should be lined up with the commutator mica, the front edge of the brush at one end of a row must not project in front of the brush at the other end.

It is most essential for proper working of the brushes that they are properly bedded. The best procedure for bedding a brush on either a dynamo or motor is as follows, viz.:—Place all brushes in their respective brush holders; obtain a sheet of coarse glass paper, and place this glass paper between the commutator surface and bearing surface of brush. Draw the glass paper in direction of rotation, taking care to lift the brush on the return passage. When the brush has taken up the curvature of the commutator, it should be finished off with fine glass paper. If any hard places are detected on the bearing face of the brush they should be removed with a file.

Always make sure that the brush fits nicely in its holder. The brush should pass through the holder without chattering. If the brush fits too tight it will be found impossible to keep an even pressure on the brush, and this leads to sparking, which in turn will cause flats on the commutator.

All makers of dynamos and motors find out the best position for their brushes and they usually put some distinctive mark on the brush-holder ring so that the fitter can see exactly where to place the brushes; and it is not advisable to alter this position without consulting the makers.

Connecting-up of Machines.

Every care must be taken in connecting-up of the dynamo or motor. The cables leading from the machine should always be protected. This can be done by placing the cables in steel conduit or in wood casing. The best method of protection must be settled on sight. The terminals of the machine should be so marked that it is quite easy to detect which is positive and which is negative. The terminals on the switch-board should also be marked. The general colours used for this marking are red for positive, and blue for negative. Should it be necessary to disconnect the cables at the machine end or switch-board end, it will be found quite an easy matter to replace each cable on its proper terminal.

When bolting the cable terminals to the machine terminals, make sure that they make good electrical contact. All makers send out with their machines diagrams of connections, and these diagrams must be adhered to.

Testing of Machines.

When the erection of the machine is completed, tests should always be made before putting the machine into commission. The insulation of the field and armature windings should be taken with a megger. In the case of a motor it should be run up and checked for proper rotation.

Makers usually paint a small arrow on the field yoke indicating the proper direction of rotation, and this arrow should never be obliterated.

While the machine is running make sure that the oil rings are working properly, and that they are lifting oil on to the shaft, and that the bearings keep quite cool.

It will be found a good plan to keep a record of insulation tests, and in many cases it will give the engineer warning of coming trouble.

CHILLED CASTINGS.

The British Griffin Chilled Iron and Steel Co. Ltd. was formed in 1899 for the purpose of manufacturing chilled wheels, chilled rolls, and castings. The works are situated at Barrow-in-Furness, and are equipped with the most up-to-date plant for turning out chilled wheels, chilled rolls, and chilled castings of all descriptions.

During its existence the Company has executed many important contracts for this class of work, and the results obtained have been highly satisfactory.

For many years the Company has made a careful study of chilled iron with the view of obtaining a standard mixture so as to give uniform results in practice, and, as an outcome of research, have put on the market a special "Komos" mixture. Castings made from this material are intensely hard in addition to being very tough, and testimonials and repeat orders are continuously received. This metal is specially suited for the manufacture of dumping bars, dumping-bar noses, and fire bars, and the use of castings made in this metal should appeal to all those who have charge of power plants, on account of the economy to be effected by their use.

Amongst other castings, the British Griffin Co. Ltd. manufacture lining plates for ball and tube mills, cones for comet crushers, mantles, stave liners, cheek liners, crusher jaws, guide plates, chilled cams, capstan heads, bollards, toothed discs, sheaves, etc.

THE INFLUENCE OF IMPURITIES ON THE MECHANICAL PROPERTIES OF ADMIRALTY GUN-METAL.*

By F. Johnson, M.Sc., Birmingham.

The literature of the subject contains little information concerning the ascertained results of adding other metals to Admiralty gun-metal. The influence of lead has received most attention. So far as the author has searched, no attempt appears to have been made to make up alloys of Admiralty gun-metal composition from pure metals under standardised conditions, and to ascertain the alteration in mechanical properties which may be brought about by the addition of other metals. This is what the author, under adverse conditions as regards time, material, and assistance, has attempted to do. Before proceeding to a description of the few experiments which it has been possible to carry out, it will be advisable to review briefly the views and experimental results of other workers.

This will be effected most clearly perhaps by taking the added elements seriatim. The choice of Admiralty gun-metal as the basis alloy may appear to some as requiring justification. The justification which the author offers is that this particular alloy finds greater favour amongst engineers than any other alloy, composed mainly of copper and tin, if the extensive and highly important series of phosphor-bronzes be excepted. The popularity of this alloy is based on no misconception. It is undoubtedly superior to its progenitor, zinc-free gun-metal.

As a casting alloy it possesses few equals among the copper-rich alloys, whilst its range of mechanical properties may be enormously extended by heat treatment. Unannealed castings are used for journal bearings, water and steam fittings, etc., whilst annealed castings are probably better for fittings of pumps used for pumping mine-waters and other corrosive liquids.

Unannealed castings have a metastable structure, the tin-rich eutectoid being present only on account of the relatively rapid rate of cooling. Thus one of the necessary conditions of a bearing-metal are fulfilled, viz., a uniformly-distributed phase (delta) of great hardness possessing a low coefficient of friction in a relatively soft matrix (alpha phase) possessing good thermal conductivity.

Annealing, if sufficiently thorough, establishes equilibrium, the eutectoid reverting to the homogeneous beta phase, this in turn passing into solution in the alpha phase.

Thus an alloy consisting entirely of homogeneous alpha may be produced by annealing, and this should be more resistant to corrosion than the metastable alpha + eutectoid structure in the unannealed casting. There appears to be no experimental evidence on this point, but it seems reasonable to assume that the obliteration of an electro-negative constituent by annealing should serve to reduce corrodibility.

The work of H. S. and J. S. G. Primrose on the annealing of Admiralty gun-metal affords striking evidence of the improvement in mechanical properties of this alloy affected by heat treatment.

The conditions recommended are—temperature, 700 deg. Cen.; time, 30 minutes.

Taking the added elements seriatim, therefore, the following is a précis of the views held by previous investigators:—

Aluminium.

H. S. Primrose states that aluminium is never found in gun-metal unless purposely added. Its ill-effects are comprised in the formation of a skin (alumina) on the skimmed surface of the molten metal, difficult to remove; in the increase in contraction and in increased corrodibility. By contraction, Primrose doubtless means the cavities formed by shrinkage of the metal during solidification. These cavities or "draws" may be obviated by efficient feeding by means of adequate runners and risers. Guillet has shown that a small addition of aluminium (leaving only a trace in the casting) enhances the mechanical properties of gun-metal of Admiralty type. (See Table IV. in subsequent issue.)

Dewrance objects to aluminium on account of the excessive shrinkage produced.

The author would point out that this increase of shrinkage must be regarded, if unaccompanied by disadvantageous structural changes, as the hall-mark of strength and soundness. One has not to seek far for an analogous case. The addition of phosphorus to tough-pitch copper results in the formation of a depression at the surface of an ingot of wire-bar which would otherwise be level. Visual examination of the fracture or microscopic examination of a polished surface proves that the addition of phosphorus has eliminated gas-cavities, and chemical examination would show that the gases which caused those cavities had also been eliminated. Thus, the condition which is opposing the natural property of the metal to become more dense, and therefore to occupy a smaller space when solid than when molten, is removed.

Physical and mechanical tests will show that the phosphorised copper is denser, stronger, and tougher.

Similar beneficial results accrue from the addition of aluminium to Admiralty gun-metal in very small proportion. The author would therefore plead for a reconsideration of the use of aluminium, believing that foundrymen could produce improved castings by observing the recommendation made by Primrose to feed efficiently. There is, however, the other, and possibly more serious, objection to its use, viz., the formation of the tenacious film of alumina which cannot be removed by ordinary skimming. This trouble is increased rather than mitigated by remelting. Possibly some efficient flux, such as cryolite, may be pressed into the service of foundrymen in order to obviate this very serious drawback to the use of aluminium. The author has greater faith in the employment of some such specific as aluminium or phosphorus for the elimination of unsoundness than in merely controlling temperature, whilst not losing sight of the fact that control of temperature, either by pyrometer or by expert judgment, cannot fail to contribute towards the same end.

(*To be continued.*)

* Paper read before Institute of Metals.

THE INSTALLATION AND OPERATION OF STATIC TRANSFORMERS.

By F. Ashton.

(*Continued from page 97.*)

Three-phase to Two-phase.

Although static transformers cannot be employed for changing from three-phase to single-phase, or *vice versa*, they may be employed, and frequently are employed, for changing from two-phase to three-phase, or from three-phase to two-phase. This transformation can be obtained by connecting two trans-

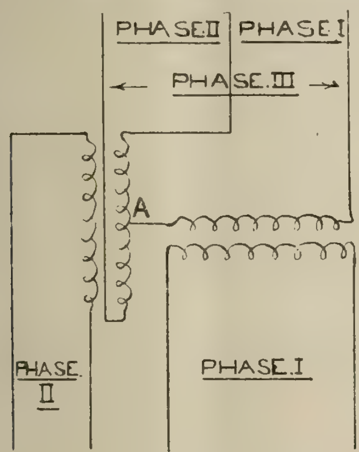

Fig. 15.—Two-Phase to Three-Phase Connections.

formers T-fashion, as shown in Fig. 15. The windings marked phase I. and phase II. are connected to the two-phase mains, whilst the other windings are connected to the three-phase mains. It will be seen that the only difference in the arrangement of the two sets of windings is that those that are connected to the two-phase circuit are used inde-

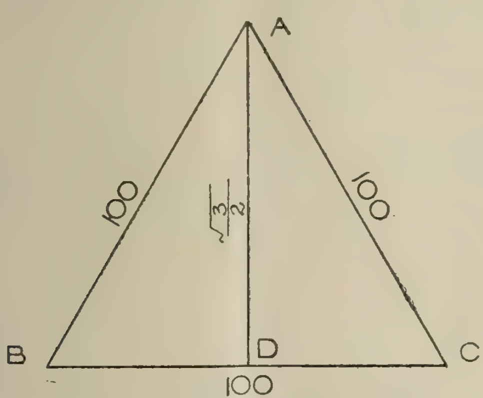

Fig. 16.—T-Connection Voltage Diagram.

pendently, whilst in the case of the windings on the three-phase side there is a T-connection at the point A. The two voltages generated in the windings are displaced by 90 degrees, and if one of the transformers has a ratio of 10 to 1, and has a tapping taken off at the middle part of its secondary, as shown, the other transformer must have a ratio of 10 to $\frac{\sqrt{3}}{2} = 10$ to 86.6 This is necessary in order to produce the equilateral triangle of voltages shown in Fig. 16. In this triangle let B C represent the voltage generated in the secondary of the first-mentioned transformer. The pressure in the second transformer, as already explained, is at right-angles to this; therefore the line D A represents in position, direction and magnitude the pressure generated in the secondary of the other transformer. The sides

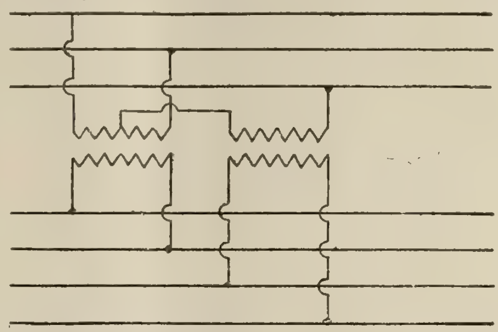

Fig. 17.—The T-Connection with Transformers having 50 per cent and 86·6 per cent Tappings.

A B, B C, and C A are equal, and the angle between them is 60 degrees. It will be understood that on the two-phase side both widings are identical, but the teaser winding on the three-phase side must have only 86.6 per cent of the number of turns in the main winding. For the sake of interchangeability, however, the main and teaser transformers are often

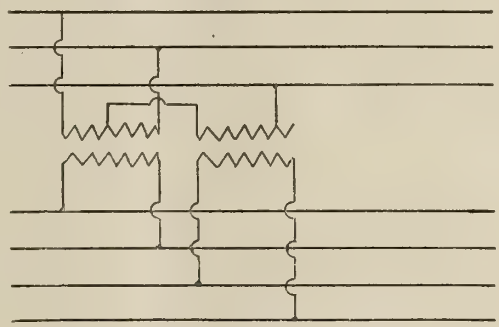

Fig. 18.—The T Connection with Two Transformers Wound for the Same Voltage.

made identical, but in this case the three-phase windings are provided with both 50 per cent and 86.6 per cent tappings, as shown in Fig. 17, so that, when a transformer is used as a main transformer, the 50 per cent tapping is used, and when used as a teaser transformer the 86.6 per cent tapping, 13.4 per cent of the winding being, in this

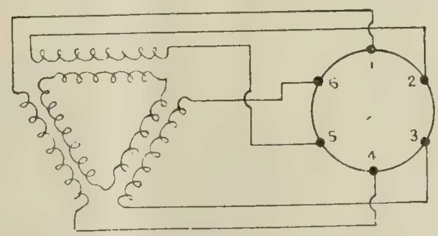

Fig. 19.—The Diametrical Connection.

case, left idle. On account of the idle copper in the teaser, and also on account of the fact that wattless currents flow in the three-phase side of the main winding, the T-connection, as shown in Fig. 17, requires 6.7 per cent more copper than single-phase transformers delivering the same amount of power.

If T-connected transformers are operated without the neutral point being earthed, the maximum strain on the insulation, if one of the windings be accidentally earthed, is that due to the full-line voltage. In cases of emergency, two identical transformers without an 86.6 per cent tapping may be used for converting three-phase current into two-phase current. Two transformers wound for exactly the same

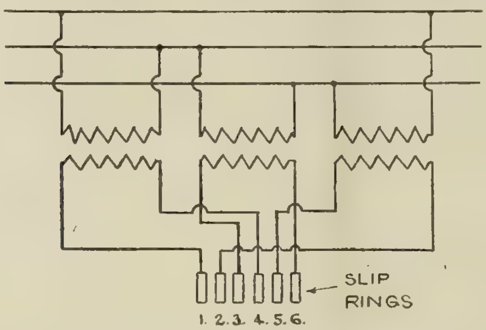

Fig. 20.—Method of Connecting Transformers to Six-Phase Rotary Converter (Diametrical Connection).

voltage might be connected, as in Fig. 18, but this will not give a true three-phase system, and the current in the various phases will be somewhat unbalanced, especially if an attempt be made to operate the transformers in parallel with other transformers or a generator. When balanced three-phase voltages are applied the voltages on the two-phase side will be unequal, and this in turn unbalances the current on the three-phase side, so that in any case the arrangement is not satisfactory. To obtain proper working, the teaser transformer must have an 86.6 per cent tapping, or must have 86.6 per cent of the turns on the main transformer.

Three-phase to Six-phase.

The transmission of six-phase currents is out of the question, because it involves the use of no fewer

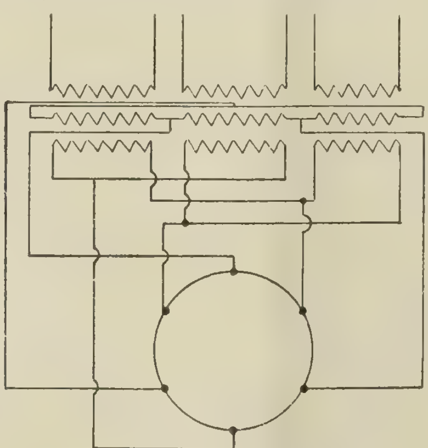

Fig. 21.—Double-Delta Connection.

than six wires, but it is nevertheless sometimes desirable to change three-phase current into six-phase current, with a view to feeding rotary converters. The copper loss in the armature of a rotary converter decreases with an increase in the number of slip rings and armature tappings, because the alternating currents are more evenly distributed in the armature windings, and in consequence it frequently happens that in sub-stations containing rotary converters the three-phase current delivered to the sub-stations is turned into six-phase current before it is supplied to the converters, which have six slip rings instead of three. This can readily be done by connecting up the transformers in various ways. The simplest and most commonly used connection for obtaining six-phase currents is known as the diametrical connection, as shown in Fig. 19, from which it will be seen that the primary windings are connected in mesh in the ordinary way, whilst the ends of each secondary winding are connected to points diametrically opposite on the armature winding. These points are, of course, connected to the slip rings, as shown in Fig. 20, where the rings 1 to 6 correspond to the points 1 to 6 in Fig. 19. It will be seen that the connections are extremely simple, and no special transformer tappings are required. Moreover, in the event of one of the transformers coming to grief, the converter may be operated at reduced capacity by cutting the faulty transformer out of circuit and leaving the other two connected in the manner shown.

The Double-Delta Connection.

Three-phase current can also be changed into six-phase current by connecting the transformers in double-delta, as shown in Fig. 21, but in this case each transformer must have two secondary windings. One set of these windings, it will be noticed, is con-

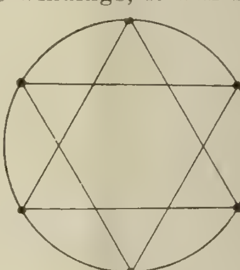

Fig. 22.—Double-Delta Voltage Diagram.

nected in mesh or delta in the ordinary way, whilst the windings belonging to the second set are all reversed and then connected in a similar manner to the first set, so that the two delta voltages are displaced by 180 degrees, as shown by the voltage diagram, Fig. 22. The primary windings should preferably be connected in mesh, for this enables a rotary converter to be operated at reduced output in the event of one of the transformers being damaged.

(*To be continued.*)

One of the German engineering papers gives a description of the wind-turbine installation of the Saxon Steel Wind-Motor Factory of G. R. Herzog, Dresden. The wheel of the motor has rigid screw-shaped blades and drives through conical gear-wheels. Its direction is adjusted according to the direction and strength of the wind. A battery, working in parallel with the dynamo, has a capacity sufficient to cover the output required for two days. An electro-magnetic switch interrupts the connection between the battery and the dynamo when the speed falls below a given value, and resistance is automatically inserted in the field circuit of the dynamo, when the speed rises. The voltage of the battery is controlled by a double battery switch. The voltage regulation of the dynamo may also be effected by a compound winding, or mechanically, by an arrangement including a slipping belt. The cost of generation is given as 4 to 7 pfennigs per horse-power hour, including interest, depreciation and maintenance.

Weights of Lengths of Rolled Steel Sections.

Beam 5 in. × 5 in. × 24 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 0 16	4 1 4	6 1 20	8 2 8	10 2 24	12 3 12	15 0 0	17 0 16	0 19 1 4	0
1	0 0 24	2 1 12	4 2 0	6 2 16	8 3 4	10 3 20	13 0 8	15 0 24	17 1 12	0 19 2 0	1
2	0 1 20	2 2 8	4 2 24	6 3 12	9 0 0	11 0 16	13 1 4	15 1 20	17 2 8	0 19 2 24	2
3	0 2 16	2 3 4	4 3 20	7 0 8	9 0 24	11 1 12	13 2 0	15 2 16	17 3 4	0 19 3 20	3
4	0 3 12	3 0 0	5 0 16	7 1 4	9 1 20	11 2 8	13 2 4	15 3 12	18 0 0	1 0 0 16	4
5	1 0 8	3 0 24	5 1 12	7 2 0	9 2 16	11 3 4	13 3 20	16 0 8	13 0 24	1 0 1 12	5
6	1 1 4	3 1 20	5 2 8	7 2 24	9 3 12	12 0 0	14 0 16	16 1 4	18 1 20	1 0 2 8	6
7	1 2 0	3 2 16	5 3 4	7 3 20	10 0 8	12 0 24	14 1 12	16 2 0	18 2 16	1 0 3 4	7
8	1 2 24	3 3 12	6 0 0	8 0 16	10 1 4	12 1 20	14 2 8	16 2 24	19 3 12	1 1 0 0	8
9	1 3 20	4 0 8	6 0 24	8 1 12	10 2 0	12 2 16	14 3 4	16 3 20	19 0 8	1 1 0 24	9

Weight of Beam advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	Weight.
	2	4	6	8	10	12	14	16	18	20	22	24	

Weights of Lengths of Rolled Steel Sections.

Beam 5 in. × 5 in. × 24 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	1 1 1 20	2 2 3 12	3 4 1 4	4 5 2 24	5 7 0 16	6 8 2 8	7 10 0 0	8 11 1 20	9 12 3 12	0
10	0 2 0 16	1 3 2 8	2 5 0 0	3 6 1 20	4 7 3 12	5 9 1 4	6 10 2 24	7 12 0 16	8 13 2 8	9 15 0 0	10
20	0 4 1 4	1 5 2 24	2 7 0 16	3 8 2 8	4 10 0 0	5 11 1 20	6 12 3 12	7 14 1 4	8 15 2 24	9 17 0 16	20
30	0 6 1 20	1 7 3 12	2 9 1 4	3 10 2 24	4 12 0 16	5 13 2 8	6 15 0 0	7 16 1 20	8 17 3 12	9 19 1 4	30
40	0 8 2 8	1 10 0 0	2 11 1 20	3 12 3 12	4 14 1 4	5 15 2 24	6 17 0 16	7 18 2 8	9 0 0 0	10 1 1 20	40
50	0 10 2 24	1 12 0 16	2 13 2 8	3 15 0 0	4 16 1 20	5 17 3 12	6 19 1 4	8 0 2 24	9 2 0 16	10 3 2 8	50
60	0 12 3 12	1 14 1 4	2 15 2 24	3 17 0 16	4 18 2 5	5 0 0 0	7 1 1 20	8 2 3 12	9 4 1 4	10 5 2 24	60
70	0 15 0 0	1 16 1 20	2 17 3 12	3 19 1 4	5 0 2 24	6 2 0 16	7 3 2 8	8 5 0 0	9 6 1 20	10 7 3 12	70
80	0 17 0 16	1 18 2 8	3 0 0 0	4 1 1 20	5 2 3 12	6 4 1 4	7 5 2 24	8 7 0 16	9 8 2 8	10 10 0 0	80
90	0 19 1 4	2 0 2 24	3 2 0 16	4 3 2 8	5 5 0 0	6 6 1 20	7 7 3 12	8 9 1 4	9 10 2 20	10 10 0 16	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t c. q. lb.	Weight
	10 14 1 4	21 8 2 8	32 2 3 12	42 17 0 16	53 11 1 20	64 5 2 24	75 0 0 0	85 14 1 4	96 8 2 8	107 2 3 12	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam $9\frac{1}{4}$ in. × $3\frac{3}{4}$ in. × 23·5 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 0 11	4 0 22	6 1 5·0	8 1 16	10 1 27	12 2 10	14 2 21	16 3 4	0 18 3 15	0
1	0 0 23·5	2 1 6·5	4 1 17·5	6 2 0·5	8 2 11·5	10 2 22·5	12 3 5·5	14 3 16·5	16 3 27·5	0 19 9 10·5	1
2	0 1 19	2 2 2	4 2 13	6 2 24	8 3 1	10 3 18	13 0 1	15 0 12	17 0 23	0 19 1 6·0	2
3	0 2 14·5	2 2 25·5	4 3 8·5	6 8 19·5	9 0 2·5	11 0 13·5	13 0 24·5	15 1 7·5	17 1 18·5	0 19 2 1·5	3
4	0 3 10	2 3 21	5 0 4	7 0 15	9 0 26	11 1 9	13 1 20	15 2 3·0	17 2 14	0 19 2 25	4
5	1 0 5·5	3 0 16·5	5 0 27·5	7 1 10·5	9 1 21·5	11 2 4·5	13 2 15·5	15 2 26·5	17 3 9·5	19 3 20·5	5
6	1 1 1	3 1 12	5 1 23	7 2 6	9 2 17	11 3 0	13 3 11	15 3 22	18 0 5	1 0 0 16	6
7	1 1 24·5	3 2 7·5	5 2 18·5	7 3 1·5	9 3 12·5	11 3 23·5	14 0 6·5	16 0 17·5	18 1 0·5	1 0 1 11·5	7
8	1 2 20	3 3 3	5 3 14	7 3 25	10 0 8	12 0 19	14 1 2	16 1 13	18 1 24	1 0 2 7	8
9	1 3 15·5	3 3 26·5	6 0 9·5	8 0 20·5	10 1 3·5	12 1 14·5	14 1 25·5	16 2 8·5	18 2 19·5	1 0 3 2·5	9

Weight of Beam advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight.	lbs. 1·95	lbs. 3·91	lbs. 5·87	lbs. 7·83	lbs. 9·79	lbs. 11·75	lbs. 13·72	lbs. 15·66	lbs. 17·62	lbs. 19·58	lbs. 21·54	lbs. 23·50	Weight.

Weights of Lengths of Rolled Steel Sections.

Beam $9\frac{1}{4}$ in. × $3\frac{3}{4}$ in. × 23·5 lbs. per foot.

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Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	1 0 3 26	2 1 3 24	3 2 3 22	4 3 3 20	5 4 3 18	6 5 3 16	7 6 3 14	8 7 3 12	9 8 3 10	0
10	0 2 0 11	1 3 0 9	2 4 0 7	3 5 0 5	4 6 0 3	5 7 0 1	6 7 3 27	7 8 3 25	8 9 3 23	9 10 3 21	10
20	0 4 0 22	1 5 0 20	2 6 0 18	3 7 0 16	4 8 0 14	5 9 0 12	6 10 0 10	7 11 0 8	8 12 0 6	9 13 0 4	20
30	0 6 1 5	1 7 1 3	2 8 1 1	3 9 0 27	4 10 0 25	5 11 0 23	6 12 0 21	7 13 0 19	8 14 0 17	9 15 0 15	30
40	0 8 1 16	1 9 1 14	2 10 1 12	3 11 1 10	4 12 1 8	5 13 1 6	6 14 1 4	7 15 1 2	8 16 1 0	9 17 0 26	40
50	0 10 1 27	1 11 1 25	2 12 1 23	3 13 1 21	4 14 1 19	5 15 1 17	6 16 1 5	7 17 1 13	8 18 1 11	9 19 1 9	50
60	0 12 2 10	1 13 2 8	2 14 2 6	3 15 2 4	4 16 2 2	5 17 2 0	6 18 1 26	7 19 1 24	9 0 1 22	10 1 1 20	60
70	0 14 2 21	1 15 2 19	2 16 2 17	3 17 2 15	4 18 2 13	5 19 2 11	7 0 2 9	8 1 2 7	9 2 2 5	10 3 2 3	70
80	0 16 3 4	1 17 3 2	2 18 3 0	3 19 2 26	5 0 2 24	6 1 2 22	7 2 2 20	8 3 2 18	9 4 2 16	10 5 2 14	80
90	0 18 3 15	1 19 3 13	3 0 3 11	4 1 3 9	5 2 3 7	6 2 3 5	7 4 3 3	8 5 3 1	9 6 2 27	10 7 2 25	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lbs. 10 9 3 8	t. c. q. lbs. 20 19 2 16	t. c. q. lbs. 31 9 4 24	t. c. q. lbs. 41 19 1 4	t. c. q. lbs. 52 9 0 12	t. c. q. lbs. 62 18 3 20	t. c. q. lbs. 73 8 3 0	t. c. q. lbs. 83 18 2 8	t. c. q. lbs. 94 8 1 16	t. c. q. lbs. 104 18 0 24	Weight

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

ENGINEERING APPOINTMENTS OPEN.

TRADE ITEMS, NOTES, &c.

The Paterson Engineering Company Limited, of India House, Kingsway, London, have received an order for supplying their rapid filtration plant to Bombay.

Messrs. Russell and Co., shipbuiders, Port Glasgow, have purchased the shipbuilders' business of Messrs. William Hamilton and Co. Limited, Port Glasgow, known as the Glen Yard. The yard has a berthage accommodation for eight vessels of the largest tonnage. Messrs. Russell will now have four of the largest shipbuilding concerns in Port Glasgow.

An Iron and Steel Exchange has been founded in London by a group of some 40 of the leading British firms engaged in the iron, steel and metal industries. It comes into being at an auspicious moment, when the whole time of industrial activity is being turned from purposes of war to purposes of peace. The secretary's office is at 113, Queen Victoria Street, E.C.4. and for the purposes of its business the London Iron and Steel Exchange Ltd. has secured the great Pillar Hall of Cannon Street Hotel.

Hydro-Electric Enterprise in Denmark.—The Danish Government has submitted to the "Landthing" (Parliament) a Bill for the erection of a large hydro-electric plant. The power will be obtained from a suitable barrage erected upon the river Guden. It is estimated that it will be possible to obtain 600 million cubic metres of water per annum, with a fall of about nine metres, which will yield a power of 10 million kilowatts, of which eight million will be utilisable. The cost is estimated at four million kroner.

Shanghai is gradually developing into an important shipbuilding centre. The Nicholas Tsu Engineering and Shipbuilding Works on the Huangpu above the arsenal is now building two good-sized steel steamers for deep-sea work. While not the largest ships built in Shanghai, being 27 ft. shorter than those of the Solvaer class built for Norwegian owners by the Shanghai Dock and Engineering Company, which has larger vessels on the ways, the sister ships now being built at the Tsu works, which has turned out several steamers for Yangtze work, will be of approximately 3,500 tons deadweight, and will measure 250 ft. length between perpendiculars (262 ft. overall), 40 ft. beam, and 25.25 ft. depth. Meanwhile, engines are being built also at the Tsu works, and if the boilers arrive from America in time the vessels should be ready for sea at the end of the year. The ships are from the designs of foreign naval architects, and are being built under foreign supervision, but the workmanship—that is, the actual labour—is entirely Chinese.

Austrian Locomotives.—At a recent meeting of the Wiener Lokomotivenbau Ges. (Vienna Locomotive Construction Co.), a vigorous protest was made against the contract concluded by the Austrian Minister of Transports with the "Skoda" establishments for the supply of locomotives to be built at the still uncompleted engine shops of the Skoda Works. The contract was made with the Skoda people because it was thought that, after the war, the exportation of locomotives would greatly assist in improving Austrian finances and industry provided such exportation were assisted by the State. Works building cars and trucks are already in a position to export; as a matter of fact, whereas in pre-war days they were able to deliver at most from 5,000 to 6,000 trucks or cars, during the war they have been able to supply the State Railways with no less than 18,000 per annum. In 1914, the six Austrian locomotive works supplied the State with 196 locomotives and 31 to private companies; in 1915, the State took 238, and only one solitary engine went to private companies; in 1916, 366 went to the State, and seven to private companies; whilst finally, in 1917, the State took 328, and private companies 44. This year, owing to the scarcity of raw materials and other difficulties, the output has materially decreased. The Scoda Works have contracted to supply 300 locomotives per annum; this will leave a good margin for exportation, even should the State require 200 per annum. An example of what can be done in this direction is afforded by the report of a German company, which has just signed a contract, on very profitable terms, to supply Bulgaria with 50 locomotives within the space of a few weeks.

THE USE OF POWDERED FUEL FOR HEATING METALLURGICAL FURNACES AND FOR STEAM RAISING.

By J. S. Atkinson,

of the Powdered Fuel Plant Co. Ltd., London.

(*Continued from page 65.*)

Control of Temperature.

The use of powdered coal offers the greatest facility for temperature control. In certain heat treatments, it is most essential to obtain a uniform temperature over a long period. In others it may be advisable to push a furnace at one period and simply hold the heat uniformly at another period. This can be done readily with powdered fuel.

Range of Temperature.

High temperatures, sufficient for open-hearth furnace, can be obtained. It is, however, possible to so regulate the admission of coal and air as to reduce the temperature to from 400 deg. to 500 deg. Cen. in a furnace requiring low temperature.

Control of Furnace Atmosphere.

Certain heat treatments require that a reducing atmosphere should be maintained in the furnace ; others, that an oxidising flame should be obtained, and again, occasionally, as oxidising flame is required in the first stages of heating, with a highly reducing flame for the final heating. With powdered fuel, as the percentage of coal to air for combustion is under mechanical control, the above conditions can readily be obtained.

Low Cost of Fuel.

Practically any quality of fuel can be burnt successfully in a powdered form. Bituminous, anthracite, peat, and lignite. It, however, is most important to bear in mind that the choice of the fuel should not be entirely governed by its cost. Certain grades of coal are not suitable for certain grades of work, although they might be satisfactory for burning in the powdered form for other purposes. It very often occurs, however, that a coal of the most suitable quality, from the point of view of analysis, can be obtained at almost a "give-away" price owing to its being too small to burn either on an open grate or in a gas producer. Such a class of coal is just what is required for burning in the pulverised form.

An ideal grade of coal for re-heating furnaces and for puddling furnaces should, if possible, closely approximate the following analysis:—

Volatile matter	not under	30%
Fixed Carbon	not under	50%
Ash	not over	9.5%
Sulphur	not over	1%

In open-hearth furnaces a still better grade is desirable, when obtainable a very suitable analysis being the following:—

Volatile matter	not under	36%
Fixed Carbon	not under	52%
Ash	not over	6%
Sulphur	not over	1%

The above analyses are given simply for guidance as being ideal, but it is possible to burn economically coals containing more than 20 per cent of ash and less than 15 per cent of volatile matter.

It is advisable to reduce the percentage of moisture carried by the coal by passing it through a dryer to 1 per cent or lower.

For steam raising, the percentage of sulphur contained in the coal can be higher than shown above. Coal containing 4.5 to 5 per cent sulphur has been successfully burnt under boilers.

Increased Output.

Owing to the high temperature of combustion obtainable by burning powdered coal, an important increase of output can be obtained under most conditions, both for metallurgical furnaces and steam raising.

Application to Existing Furnaces and Steam Boiler Plant.

In nearly all cases the application of powdered fuel to existing furnaces and boiler plants can be carried out with small cost in alteration, no matter whether the plant was previously fired by hand, gas or oil, the powdered fuel burners being fitted to the existing combustion chambers.

Smokeless Combustion.

The combustion of powdered coal can be carried out practically smokelessly, this being due to the fact that all combustible matter is consumed by the intimate mixing of the gas and coal particles. This should prove a great advantage in large towns.

Rapid Heat-Raising.

In burning powdered coal the full temperature of combustion is reached immediately the furnaces or boilers are started up. The full furnace working temperature can be reached or steam can be raised from cold water far more quickly than with hand firing on a grate.

As soon as the furnace or boiler is stopped, no further fuel is burnt, as in the case of hand firing, when the full amount of coal has to be kept in the grate up to the last moment of working. This constitutes an important saving in fuel in favour of powdered coal firing.

With powdered fuel the action is continuous, and there is no stoppage for grate cleaning. The heat generated is uniform and steady.

Ash Handling.

As the greater part of the ash is carried away up the chimney in the form of a light vapour, an important saving in the cost of ash handling is effected.

General.

Other advantages connected with the use of powdered coal may be mentioned, particularly in connection with steam raising, but we propose to deal with this subject separately.

Risk of Explosion.

The risk of explosions occurring through the use of powdered fuel has been much overestimated and, in a plant properly designed, there is no more risk attached to this system of burning fuel than in connection with the use of producer gas or oil. Far more risk is attached to the use of blast furnace gas or coke oven gas, which have large industrial usages.

Mr. James Lord, President of the American Iron and Steel Manufacturing Co., has said that in over 100 furnaces, of various types, installed at their

works, and over a period of ten years, no explosions have occurred.

Cost of Preparing Powdered Coal for Burning.

The cost of preparing powdered coal for burning, including power, labour, fuel and depreciation of plant, is usually less than the cost of gasifying coal in producers.

First Cost of Plant.

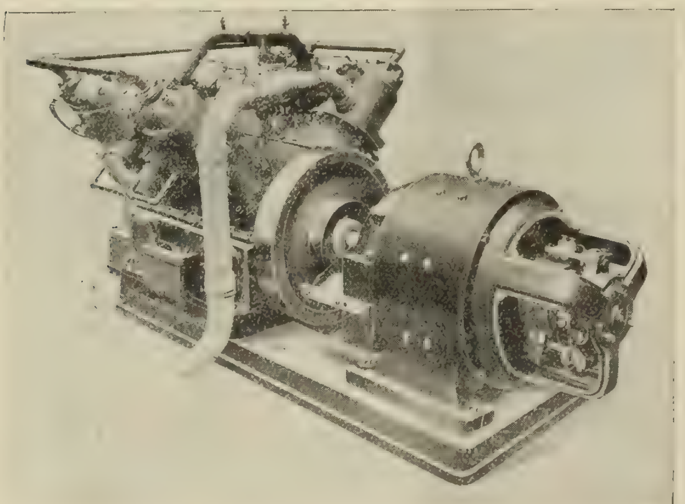
The first cost of the plant for preparing powdered coal compares very favourably with the cost of a similar gas producer plant.

(*To be continued.*)

THE "RECORD" INTERNAL-COMBUSTION ENGINE.

These engines, made by the Record Engineering Co. Ltd., Eccles, Manchester, have been on the market for some years; but only recently have they come into prominent notice. They are the result of long experience and careful study of the inherent defects of the internal-combustion engine. The main objects in the design have been reliability and simplicity, and these have certainly been very effectively attained, as will be seen from the particulars we are now in a position to publish.

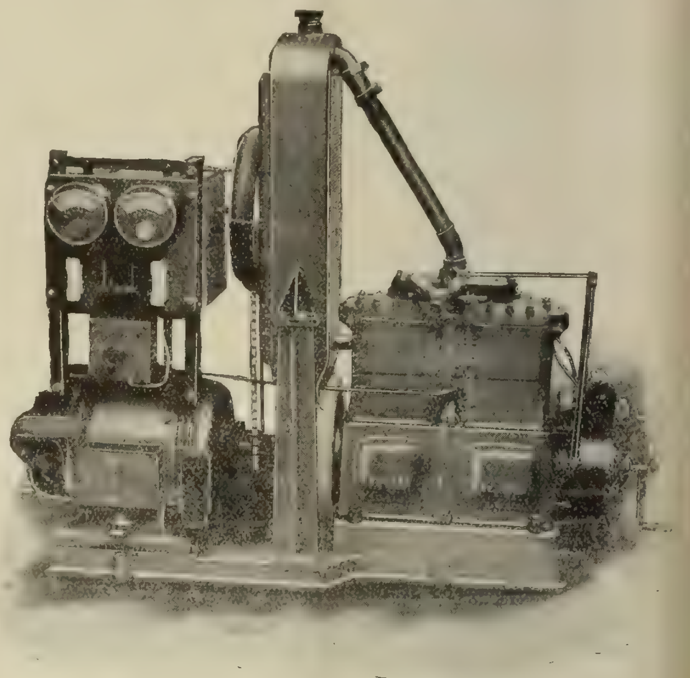
The engines are designed on similar lines, and may very well be compared with the well-known high-speed self-lubricating steam engine. All the usual two-to-one gears with their cam shafts, cams, tappets, and poppet valves—as used in connection with the ordinary four-stroke cycle engine—have been eliminated. Consequently, this engine simply consists of the usual pistons with rings, and, generally speaking, one simple piston valve for every two cylinders; this piston valve being driven by means of an eccentric formed with or fixed directly on to



The "Record" Internal-Combustion Engine.—Fig. 1.

the crank shaft. This constitutes the whole of the valve mechanism, and as this valve only controls the distribution of the gaseous fuel to the pump cylinders, it is only subject to a few pounds pressure per square inch, and never to the heat or fire, and consequent carbonisation, etc., of the working cylinders.

It will readily be seen that these engines, being of such simple construction, are capable of maintaining their efficiency over very long periods. They are



The "Record" Internal-Combustion Engine.—Fig. 2.

easy to overhaul and repair, and can be placed in the hands of unskilled labour for supervision. Attendants that have had experience in the running of steam engines will find they closely approach the plant they have been accustomed to. It is, therefore, the type of engine which will appeal particularly to marine engineers.

Two-cycle engines have, in the past, been generally looked upon with disfavour owing to their great inefficiency and other defects; for instance, the crank case has generally been used for handling the fuel mixture resulting in carbon and soot being deposited on the bearings and fuel oil being mixed with the lubricating. This, in many cases, made the engine very liable to give trouble due to hot bearings, leakages, excessive oil consumption, and general inefficiency.

In the "Record" engine, this cause of trouble is entirely removed, the crank case only being used as a reservoir for lubricating oil as in the ordinary four-cycle engine; in reality, it works under more favourable conditions, owing to the fact that the lubricating oil is not splashed directly on to the inside of the working pistons.

The Record Engineering Co. Ltd. have now set up a new "record" in endurance and efficiency, as they have recently completed a six-days' endurance test on paraffin, on one of their 50 B.H.P. engines. This engine was an order for a Government Department, and one of the conditions under which the engine was placed was that it would run continuously night and day, at full load, on paraffin without any attention or adjustment whatsoever. These conditions were

accepted by the Record Engineering Co., and the trial carried out under the direct supervision of five Government departments who were interested in the result. During the whole of the trial, the engine received no attention except the usual filling up of fuel tanks and the addition of lubricating oil. No plugs were changed, and when afterwards dismantled, the engine showed no appreciable wear and the cylinders were practically free from deposit. The result of this test proves once and for all that a two-stroke engine can be designed and built to give equal results in economy, efficiency and endurance to a four-stroke engine, with the added advantages of great simplicity and consequent increased reliability.

As is well known, the two-stroke engine fires every revolution, consequently a two-cylinder engine will give equal turning moment to that of the four-cylinder four-stroke. The engine recently tested was of the "V" type, four-cylinder design, with two cranks giving four impulses per revolution, making the turning very even, and owing to the absence of valves and valve gear, the engine runs silently under all conditions of load, and absolutely free from vibration.

Fig. 1 illustrates the side elevation of the 50 B.H.P. engine referred to, whilst Fig. 2 illustrates the standard 5-kw. petrol generating set with radiator system of cooling. Generally speaking, the engines are substantially designed as regards the working parts, and ample provision is made for wear, while large doors are provided in the crank case to enable adjustments to be made without dismantling. It will also be seen from the illustrations that the cylinder heads are made loose, consequently both piston tops and combustion chambers can be cleaned without dismantling the parts.

The London office of the Record Engineering Co. Ltd. is:—Donington House, Norfolk Street, Strand, W.C. 2, and Mr. J. Martin Blair, Resident Director, will be prepared to supply any prices or information regarding the engines.

ENGINEERING LAY-OUT ARRANGEMENTS AND TENDER DRAWINGS.

By DOUGLAS WILSON, A.M.I.Mech.E.

(Continued from page 93.)

The Duplicate System.

The duplicate system of distribution is indicated at Figs. 32 and 33. As will be seen, there are two complete separate mains to each pair of engines, thus preventing any inconvenient stoppage due to a

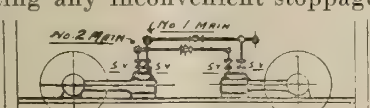


FIG. 33.

pipe or joint failing. In some pumping and lighting stations this precaution is advisable, in spite of the extra losses due to condensation, though few engineers adopt it, as the material now used in steam piping is very trustworthy, and the design of flanges, joints, etc., has improved very much this last few years. Some authorities consider this system necessary where stoppages involve much expense and risk to life.

Existing conditions govern the choice of a system,

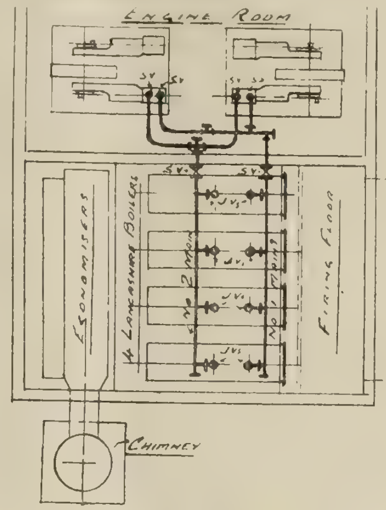


FIG. 32.

and no hard and fast rules can be laid down for any one arrangement. As will be seen from the diagram each engine is provided with two stop valves, a special bend pipe or Y-piece being required, or the

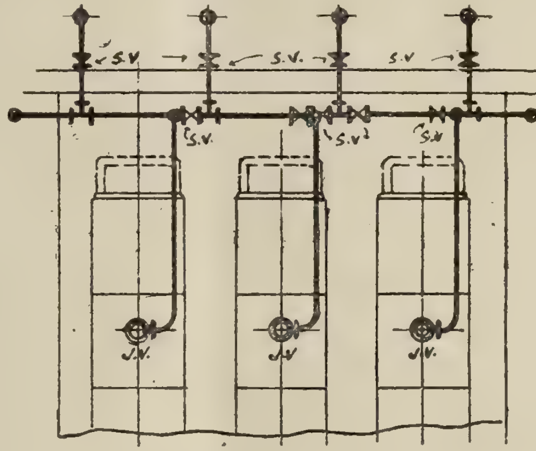


FIG 34.

steam chests designed for duplicate inlet connections. All this more or less complicates and adds to the cost of the installation.

The Ring Main System.

The ring main system is another expensive

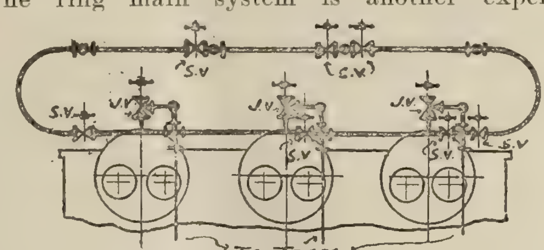


FIG. 35.

luxury in steam pipe lay-out. This method is shown at Figs. 34, 35, 36, in diagram form. This system was very popular years ago, when the material employed in pipes was of a poor quality, and was

frequently adopted in large electric power plants, as, in the event of a breakdown, any engine can be fed from either direction. As will be seen from the diagrams, the number of joints and valves to affect this is, to say the least, alarming, to say nothing of the large radiating surface entailing loss, also additional supports, drainage connections, etc. Further, there is always the danger of a portion of the main being shut down, and suddenly opened up in the case of emergency, this being a dangerous practice, inviting water hammer to take place in the cold pipe due to condensation, thereby blowing out the

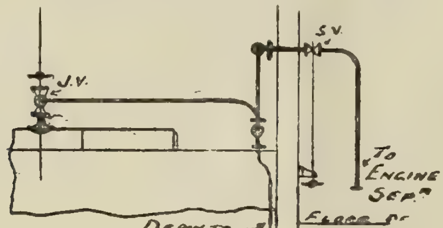


FIG 36.

joints. The ring must be of equal diameter throughout, as it must carry all the steam any way round, and the valves should be easily accessible, preferably extended spindles being adapted to bring the hand wheels within easy reach of the engineer. Undoubtedly this system gives a high factor of safety to a power plant, but the author favours the well-designed "simple" system, as the best materials can nowadays be depended on, the renewal of a joint ring now and again being the only cause for a short stoppage.

(To be continued.)

THE SEMI-DIESEL ENGINE.*

At a recent meeting of the Diesel Engine Users' Association, Mr. James Richardson, of Messrs. William Beardmore and Co. Ltd., read a paper on "The Semi-Diesel Oil Engine," which he defined as an internal-combustion engine using oil fuel, but having an uncooled portion of the combustion chamber at high temperature to help in the vaporisation and ignition of the injected fuel. He excluded from this definition certain oil engines which, although not called Diesel engines, yet approximated to this type, relying on the heat of compression for ignition.

The Chief Claim of the Engine.

The chief claim of the semi-Diesel engine was its simplicity, and it was for this reason that the majority of engines of this type were made on the two-stroke principle and were confined to comparatively low powers per cylinder.

Air Injection.

Air injection of the fuel had been used in earlier types of engines, but as this had led to extra complications in the way of compressors, etc., the modern type of engine worked on the "solid" injection principle in combination with the hot bulb for vaporising and igniting the fuel. Air compressors were now sometimes used on semi-Diesel engines, but more for taking the place of the water drip in cooling the combustion chamber than for the injection of the fuel.

Compression.

In the matter of compression, the advantage of high compression, which, according to theory, resulted in economy in fuel and a higher mean effective pressure per cylinder, was counterbalanced by an advantage of low compression in the more even turning moment and a higher mechanical efficiency.

The semi-Diesel was a variable compression engine, high compression being limited to that at which the compression alone ignited the charge, and the lower to that at which the size of the hot bulb became inconveniently large. Although high compression was theoretically advantageous, from practical considerations, there was a point above which it was inadvisable to go due to losses incurred by piston friction. The higher the compression the greater the loss due to this source, a large number of rings being required. On this account the mechanical efficiency of the internal-combustion engine was low compared with that of the steam engine

Fuel Economy.

As regards fuel economy, the semi-Diesel engine gave very satisfactory results, as its cycle of operation was nearer the economical explosion cycle than that of the Diesel engine.

Flexibility.

In the matter of flexibility, the semi-Diesel engine was really a constant load and constant speed engine. Flexibility could be considered under three headings:—

(1) Constant M.E.P. with varying power and revolutions.

(2) Constant speed and varying M.E.P.

(3) Varying speed and M.E.P.

Condition (1) need not be considered from a practical point of view.

After considering the second condition in detail, Mr. Richardson pointed out that even where means were provided for throttling the cooling water and scavenging air, a point was quickly reached where the heat of the bulb was insufficient to ignite the charge, and the engine consequently "missed."

The Water Drip.

The water drip was used in order to extend the range of working to cover from overload to a small load without recourse to the blow lamp. At full load the water served to take heat from the bulb so that a low-compression engine with a fairly large bulb could run from $\frac{3}{4}$ to full load satisfactorily. By cutting off the water low load could be reached. The water for this purpose should be as pure as possible to prevent deposits. It had a deleterious effect on the lubrication of the internal parts and was only a crude solution of the problem.

The better solution was to *vary the point of ignition* of the fuel charge to correspond with the load on the engine. Gears had been designed by means of which, in conjunction with the governor, the ignition might be varied according to the amount of fuel admitted to the engine.

Scavenging.

In the matter of scavenging, the efficiency was lower in the 2-cycle engine than in the 4-cycle, for which reason the 2-cycle engine had not achieved the success which had been predicted for it, as the amount of air available per cylinder was limited to the volume swept by the piston. In addition to this the air drawn in to the crank chamber was impregnated with lubricating oil, and had a cooling

* Abstract of Mr. Jas. Richardson's paper read before the Diesel Engine Users' Association, October 24th, 1918.

effect on the working parts. The scavenging efficiency consisted of the efficiency of the pump and the efficiency of the scavenging of the cylinder, and was affected by losses due to the pump. Probably the greatest loss in efficiency concerned the scavenging in the cylinder. The size and shape of scavenging, exhaust passages and ports, had a great effect on the efficiency, and large exhaust ports, ample passages, and a minimum of restriction in the exhaust ports were a necessity.

Stroke to Bore Ratio.

The subject of stroke to bore ratio was intimately associated with this question, and Mr. Richardson's experience suggested that the larger the stroke to bore ratio, within limits, the less the escape of scavenging air through the exhaust.

Injection.

The question of injection depended primarily on several factors of which turbulence, point of cycle at which injection occurred, fineness of spray and distance of injector from hot igniting surface, might be mentioned. Turbulence was on a par with the question of scavenging, and had, as yet, received little attention. With regard to the period of injection, practical considerations determined the period for full-power running to be about 30 deg. No standard had been fixed for fineness of spray, although this could be too fine. It was essential that the whole of the oil should be in the combustion chamber in the form of a spray before the first particle touched the hot bulb, which argued for a long throw of the fuel, although this militated against flexibility.

In the matter of fuel it was only a few years since that the majority of semi-Diesel engines required paraffin or the very lightest type of fuel oil, and the great outstanding difference between the Diesel and the semi-Diesel had been the small range of fuels with which the latter could cope. Recently the producers had been led to experiment in the use of heavier fuel oils more readily obtainable.

At present the engine could use most oil fuels ranging between .8 and .9 in specific gravity. Shale oil had been most frequently used. Heavy oils required pre-heating to facilitate pumping. In this connection it should be noted that the semi-Diesel, being of the "solid injection" type, did not run with as clean an exhaust as the Diesel, and on this account the amount of overhauling of parts required was greater.

As regards lubrication, this was carried out in almost a similar manner to the Diesel engine, the consumption working out at about .02 lbs. per brake horse power.

The starting of the engine was carried out by means of compressed air, a compression of from 80 to 100 lbs. per square inch being necessary. The bulb, prior to starting, was made sufficiently hot to ignite the fuel, one impulse being usually enough to start the engine.

The reliability of the semi-Diesel engine was of high order, especially in the modern types, with ample bearing surfaces and carefully-designed means for the provision of the necessarily restricted quantity of lubricating oil.

In conclusion, Mr. Richardson referred to the recent extension of the field of application of this engine, and to the increase in the size of engine and power developed; he foreshadowed great developments in the near future. It might be expected that the lines of development of the semi-Diesel and the Diesel engines would become more closely merged.

Practical difficulties appeared to confine the semi-Diesel engine to the 2-stroke principle, and improvements in the scavenging efficiency might be expected.

The question of "solid injection" became a simpler issue when associated with surface ignition. All considerations in the design of the fuel pump gear and the injection had been subordinated to simplicity, but with the increasing demand for the same degree of flexibility and a capacity to burn as wide a range of fuels as the Diesel, considerable improvements after the war might be expected.

Mr. James Richardson's paper is to be discussed at the following meeting of the Diesel Users' Association, when it is understood that several engineers and users of semi-Diesel engines will attend. Applications by non-members for invitations to attend the meeting should be addressed to the Honorary Secretary, Mr. Percy Still, M.I.E.E., 19, Cadogan Gardens, London, S.W. 3.

ON THE DETERMINATION OF THE TEMPERATURE RISE OF OIL CIRCUIT BREAKERS.

By G. E. Gittens, B.Sc. (Lond.).

It is usual for switchgear draughtsmen who are engaged in the design of oil circuit breakers to work to a specified temperature rise which shall not be exceeded under full load continuous service conditions.

Reducing Switch Watt Loss.

Generally no heating trouble is experienced with breakers up to 1,000 amperes current capacity if reasonable care is taken to keep the contacts and arcing tips in condition, and to maintain the oil at its correct level in the tank. When, however, current ratings of 3,000-4,0000 amperes are required, it is of the utmost importance to reduce the switch watt loss as much as true economy in material will permit, otherwise trouble will assuredly follow.

The watt losses in the switch fall into two groups: (1) the copper loss, (2) the tank loss. There is no difficulty in arranging for the latter loss to be negligibly small, as the only necessary and sufficient condition is to give such clearance between the current-carrying parts and the tank walls (sheet steel being assumed) as will prevent the latter from being worked at a high-flux density.

Best Methods of Reducing Copper Loss.

The best methods to be employed in reducing the copper loss require both skill and experience, and the beginner should keep the following considerations carefully in mind as the design is proceeded with.

The copper watt loss consists of three items:—

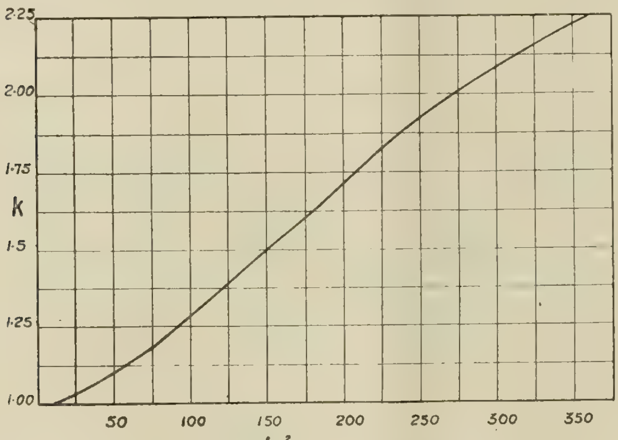
(1) The I^2 R loss in the stationary stems.
(2) The loss over brush and contacts; and
(3) The eddy current loss.

In proportioning the cross-sectional area of the stationary stems, the current to be carried, and the frequency must each be considered. The maximum current density is reached in that part of the conductor in which the magnetic field is strongest, and this phenomenon, known as the "skin effect," produces an increase in the resistance and a reduction in the self-induction of the conductor. Where a field in a conductor is due entirely to the current in that conductor, then the current density is greatest at the periphery and least at the axis of symmetry. It is

clear, therefore, that it will not do to assume haphazard a sectional area based upon some such figure as 1,000 amperes per square inch, if the best results are to be obtained. Solid stem conductors of circular cross-section up to one inch in diameter, and on periodicities not greater than 60 cycles, may be economically employed. Cases of combined high voltage, heavy current, and large breaking capacity, where the stud passes through a long porcelain, should receive especial attention.

Economy in copper may be effected in the larger sizes, and on frequencies of 50 periods and upwards, by using stems of tubular cross-section, providing that the thickness of the wall does not exceed $\frac{3}{8}$ in. Thus, a copper tube having an outside diameter of two inches, and inside diameter of $1\frac{1}{4}$ in., might safely be used to deal with 1,500 ampere 50 period current.

Solid stem conductors of 2 in. diameter and above would not usually be employed for heavy current switches, except in cases of low periodicities. As a rule, it is preferable to build up the heavy stationary



Determination of Temperature Rise.—Fig. 1.

contact stems of copper strap, not greater than $\frac{3}{8}$ in. thick and of such width that, when assembled, they approximate to a shape which gives the least periphery so as to avoid unduly large porcelains.

Estimating Effective Resistances of Solid Stems.

The curve, Fig. 1, will be found useful in estimating the effective resistance of solid stems of circular cross-section on frequencies of 40-60 periods.

The values of $k = \dfrac{\text{effective resistance}}{\text{ohmic resistance}}$ are plotted against $f\,D^2$ (frequency × diameter^2) where D is in inches. As an example in the use of the curve, suppose we require the watt loss on a 2 in. diameter stud conductor 20 in. long when carrying 2,000 ampere 50-cycle current.

First, find the ohmic resistance, assuming the specific resistance of commercial copper at 50 deg. C. to be $\rho = 0{\cdot}765 \times 10^{-6}$ square inch ohms per inch.

$$\text{Now R} = \frac{l\rho}{S} = \frac{\text{length} \times \text{specific resistance}}{\text{cross section}}$$

$$= \frac{20 \times {\cdot}765 \times 10^{-6}}{4 \times {\cdot}7854}$$

$$= 4{\cdot}86 \times 10^{-6} \text{ ohms.}$$

Also $f\,D^2 = 50 \times 4 = 200.$

From curve $k = 1{\cdot}7$, and hence effective resistance

$$= 4{\cdot}86 \times 10^{-6} \times 1{\cdot}7$$
$$= 8{\cdot}26 \times 10^{-6} \text{ ohms.}$$

The watt loss due to the skin effect is current^2 × effective resistance

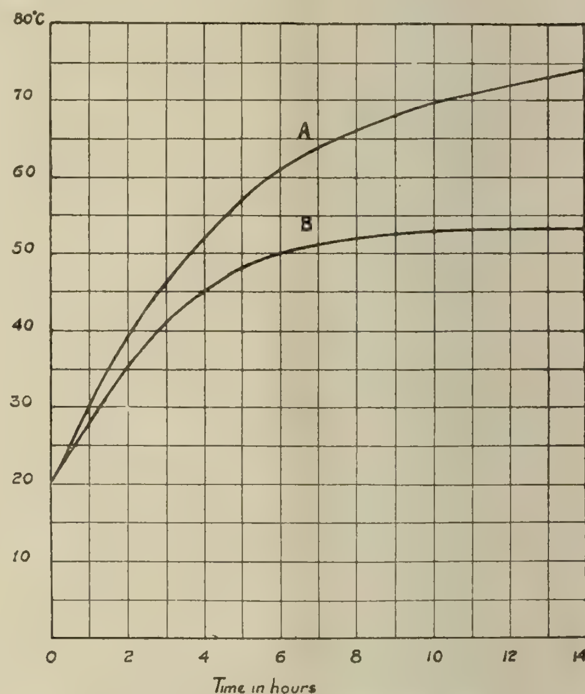
$$= (2000)^2 \times 8{\cdot}26 \times 10^{-6}$$
$$= 33 \text{ watts.}$$

If the frequency is 25 cycles or less, the skin effect may be neglected on conductors up to 3 in. diameter.

Where a correction is required, the expression

$$k = 1 + 10{\cdot}5\left(\frac{D^2}{10^3}\right)^2 - 900\left(\frac{D^2}{10^3}\right)^4$$

may be used to obtain k.



Determination of Temperature Rise.—Fig. 2.

Dissipation of the Watt Loss.

The losses in the switch are dissipated by convection currents in the oil, which carry the heat to the tank walls, whence it escapes by radiation into the air. The heat flux which passes outwards along the copper stems is of the order of four watts cm. per sq. cm. per C° difference of temperature; but the best plan is to neglect this, and to assume that all the losses have to be dealt with by the tank surface, and base the estimated temperature rise upon this. In arriving at a figure for the tank surface usefully employed in dissipating the heat, it is important to take into account the shape and disposition of the tank lining and to arrange that the lining admits (in the larger current capacities) of the hot oil coming into intimate contact with the tank walls. A layer of oil at least $\frac{1}{2}$ in. thick, between the lining and the tank, should always be provided for. Care must also be taken to see that the surface of the oil stands 1 in. or more above the top of the lining, and that the lower edge of the lining does not rest upon the tank bottom for the whole of its periphery. Neglect of these precautions will reduce the convection currents in the oil which are due to changes in density, greatly

nullify the advantage of a large tank surface, and result in increased temperature rise. As an illustration of the importance of this, curves A and B, Fig. 2, showing the effect of bad and good circulation of the oil, should be noticed.

(*To be continued*).

Publications.

The Austin Motor Co. Ltd., of Longbridge Works, Northfield, Birmingham, have published a "Handbook of Instructions," in combination with a "List of Details," concerning their small generating sets. These machines are made in sizes varying from 3 to 18 kw., are self-contained power units, comprising a multi-cylinder engine, direct coupled to a generator, the whole coupled with all accessories mounted on a bedplate. Cooling is maintained by a fan-cooled radiator; on the 3 and 3.5 kw. sets the thermo syphon system of circulation is used, those of the 8 kw. and 18 kw. capacities having pump circulation. As an alternative suitable tanks may be used in place of radiators, the 18 kw. sets may be also arranged with radiator, oil, and petrol tanks separate from the machine, in which case the fan is driven by means of a small motor, mounted on the cast-iron base of the radiator. All spare parts are illustrated and numbered, and detailed information is given with reference to ordering the same. Much care has been taken in compiling this little book; excellent illustrations are given of machines, showing both admission and exhaust sides of the engine, the various parts in most cases being where possible marked with the pattern number. Much useful information is given with reference to the maintenance of these sets, their causes of breakdown, etc., which should be of the greatest value to prospective buyers and users of these machines.

A good sensitive drill is a boon to the engineer's shop. **The Royersford Foundry and Machine Co.,** of Royersford, Pa., U.S.A., makers of "Excelsior" machine tools, in their brochure No. 21, illustrate three very efficient articles in this direction—the "Excelsior" 10 in. for bench or column use (largest size drill $\frac{3}{8}$ in.)—the "Excelsior" 14 in., made both for column use or fitted with a motor and worked as a separate unit, the latter size taking drills up to $\frac{1}{2}$ in. This firm also illustrate several types of their 20 in. "Excelsior" drilling machines, taking drills up to $1\frac{1}{4}$ in., and arranged for four speeds, lever feed, and automatic stop attachment. An improved pattern is the 20 in. "Excelsior" back-geared drill, having eight speeds, power, hand-screw, and liner feed, and can be purchased either for working from the line shafting or supplied with a motor, and run as a separate unit. A notable feature regarding these machines is the facilities which are offered for the speedy setting up of the work in hand. Illustrations of presses, grinding, and buffing machines are given, and information regarding the dimensions, weights, and in some cases the horse-power absorbed.

The Royersford Foundry and Machine Co. do not confine their products to machine tools only. Their "Bulletin D" describes the "Sells Roller Bearing," by the adoption of which it is stated that a reduction in friction losses varying from 25 per cent to 40 per cent, and in exceptional cases 65 per cent is obtained. These bearings are made to fit shafts from $\frac{7}{8}$ in. to 6 in. in diameter, all parts are split, permitting easy application, their dimensions allowing their use in almost all modern standard hanger, post hanger, and pillow block frames, whether steel set-screws, cast-iron plungers, or screws are used. A special bearing is made for heavy load stresses, consisting of a double roller in place of the single, which is used for all normal working conditions. A peculiarity of the design is that no wear takes place on the shaft, which is encased in a diagonally-split steel bushing kept in place by means of a slit-collar at each end. All working parts are manufactured to micrometer gauge, and the box is accurately bored, which should be very beneficial regarding the question of replacements. In addition to the "Sells Roller," the firm illustrate in their Catalogue No. 14 various types of hangers and blocks fitted with Babbitt's metal bearings; also numerous shafting accessories, etc. A special lubricant is also described, claimed to be the ideal lubrication for shafting; also a novel lubricating syringe, the piston-rod being arranged as a rack, the lubricant being admitted to the desired object by means of a small pinion and handwheel.

In our issue of October 8th last, we briefly remarked upon the "Uses of Liquids" (consisting of fused salts and mixtures of salts) in the heat treatment of carbon and high-speed steel. **Messrs. The Brayshaw Furnaces and Tools Co.** (associated with John Wright and Eagle Range Co. Ltd.), of Mulberry Street, Hulme, Manchester, have forwarded us their illustrated catalogue entitled "Brayshaw Furnace Specialities." This little booklet deals extensively with various types of furnaces, baths and ovens, heated by coal producer-gas, oil, or solid fuel, for the treatment of steel, muffles, and crucible furnaces for the melting of metals.

Attention is called to the "Auto-Gas" patent producer, using gas coke, or any non-bituminous fuel of suitable grade. This apparatus has many notable features relating to simplicity of operation, and it is claimed that about four hours' full capacity of working can be obtained on one charge, no difficulty being experienced in obtaining temperatures from 2,200 to 2,550 degs. Fah. in glass-melting furnaces by the use of this gas. This catalogue also contains several illustrations of fans, blowers, thermometers, and temperature-measuring and recording instruments. Three pamphlets are also enclosed, entitled "Coal-gas as a Fuel for Melting Non-Ferrous Alloys," "Metal Melting, as practised at the Royal Mint" (reprinted from the "Metal Industry," March 30th, 1917), and "Coal-Gas for the Heat Treatment of Metals, and other purposes" (reprinted from "A Thousand and One Uses for Gas," October, 1917). These are most interesting papers, containing a fund of information concerning the construction of these furnaces, and their behaviour compared with other apparatus designed for a similar purpose. Those interested in this subject should communicate with this firm, who, we feel confident, will be most willing to discuss in detail any technical points which might be put forward.

Letters to the Editor.

The Editor will always be pleased to hear from readers who desire to express their opinions upon engineering and kindred subjects. Letters should be as brief as possible and be written upon one side of the paper only. The insertion of a letter in our columns does not necessarily mean that we endorse the opinions expressed therein.

THE STEAM LOOP.

To the Editor of "The Industrial Engineer."

Sir,—In reply to Mr. Parsons' letter in your issue of December 8th, I still maintain it is impossible to obtain dry steam leading to the engine from a separator fixed in such a position shown in his sketch of which he terms the "Holly" steam loop.

If Mr. Parsons will take the trouble to insert a drain-cock in the position that I stated in my letter, he will find that he will be able to draw off a certain amount of water.

Then he desires to know if I have not seen or heard of the "Holly" steam loop. I beg to inform him that I have had this arrangement, which a firm of engineers had installed, and proved to be a source of trouble, viz., water. I suggested that it should be removed, which has been done within the past twelve months, and the desired results are being obtained. This system had been in operation for a period of ten years. Another similar case has also come to my knowledge, and is being discarded for the same reason, but not at my suggestion, within the last month.

The syphonic action was a mere suggestion of which I am quite aware is neither practicable nor theoretical.

Further, I did not state that it was impossible to return water back to the boiler from a point below the level of the boiler, but that he did not obtain dry steam from the separator so that the separator can do the duty it is intended to do.

Jas. Warhurst.

Mossley, December 16th, 1918.

The Minister of Munitions hereby gives notice that all uncompleted contracts for the Admiralty, War Office, and Ministry of Munitions which have been placed in Classes A or B, including the various grades thereof, P1, P2, P3, P4, P5, and P6, under the Order as to Priority of March 8th, 1917, need no longer be given the priority attaching to them under the Order, except in cases where the contractor is notified in writing or by official notice in the Press that a particular classification is still required to be given to any particular contract. Contractors must notify the ordering Departments of the Admiralty, War Office, or Ministry of Munitions responsible for the contracts in question, of any modification of the original date of completion resulting from this relaxation of the Order as to Priority.

Trade Items, Notes, &c.

The Council of the Society of Engineers have awarded the President's Gold Medal to Mr. T. Roland Wollaston, of Corporation Street, Manchester, for a paper on "A Survey of the Power By-product Problem."

A new dockyard company is being promoted by several businessmen in Osaka at Itozaki on the Inland Sea, with a capital of 3,000,000 yen. It is planned by the new company to build or manufacture ships, boilers, tools, machines, and other goods, and also salvage or repair steamers.

According to investigations made by the Department of Communications, 65 steel steamers, each over 1,000 tons, and aggregating 193,417 tons, were launched in Japan during the first half of this year. The figures show an increase of 36 steamers, aggregating 74,079 tons, as compared with the corresponding period of last year.

A great combination of steel interests is in course of formation to compete with the United States Steel Corporation for foreign trade. More than 25 concerns have agreed to pool their interests and send commercial representatives to every nation in Europe for contracts. The combination includes the Bethlehem Steel Corporation, the Briar Hill Steel Company, the Jones Laughlin Steel Company, the Lackwanna, and other steel companies, and the Colorado Fuel and Iron Company

The Minister of Munitions has issued an Order dated 13th December, revoking the Boilers Returns and the Boilers Control Orders, which provided respectively (*a*) for the making of certain returns, and (*b*) that no person except with a permit might purchase, sell, or deal in any second-hand steam-pressure boiler, other than boilers for use in locomotives, motor cars, vehicles or ships. The Order did not, however, authorise dealing in boilers for which a permit is required under the Railway Material (Second-hand) Order, 1916.

At the works of the Barrow Steel Co. Ltd. important changes are being made, and others will be taken in hand as soon as possible. A blastfurnace is to be erected, capable of producing a large output of pig-iron, and gas-producing plant is being extended. In the steelworks the Bessemer departments will again be at work in the first week of the New Year, and rails in large quantities will be rolled. Extensions are in hand in the steel foundries, so that the company can tackle the big castings wanted for cargo and passenger steamers. In the plate mills developments are expected so as to enable the company to meet the big demand that is sure to come on account of mercantile shipbuilding.

The first concrete ship built in Scotland has just been launched at Greenock by the Scottish Concrete Ship Co. Ltd. Built to the order of the Controller-General for Merchant Shipping, the new vessel is a barge, 180 feet long, with a carrying capacity of 1,000 tons deadweight. The building of standard ships goes on apace, and in launching their seventh vessel of this type from their Govan yard, Messrs. Harland and Wolff have demonstrated very clearly what can be accomplished when exceptional circumstances arise. This new vessel belongs to the "A" type, is of 8,200 tons deadweight, and 400 feet in length by 52 feet beam, while the machinery installation has been supplied by the Diesel Engine Works, Glasgow, now a very important branch of the firm's activities.

Silicium as a Protector.—If metallic iron at an incandescent heat be brought into contact with tetrachloride of silicium, then chloride of iron will be produced, free silicium being separated off at the same time. Hitherto this process has only been used for coating the incandescent bodies of electric heating or lighting devices with silicium so as to protect them from all atmospheric influences. Recent experiments made by a Vienna firm have shown that the reaction in question also affords a basis for providing all kinds of metal articles with a thick coating of silicium (or of a silicium compound), whereby they are rendered not only air, but also acid, proof. The articles in question, if of iron, are treated whilst hot with halogen combinations of silicium, or silicon, as it is nowadays more generally called. Non-metallic articles must first of all be treated with a metallic coating, to which the silicon or silicon combination is then subsequently applied.

The large Swedish concern Ljusne-Voxna, which is going to acquire its own tonnage, is constructing a dry docks, both for its own and other vessels on a novel principle. The dock, which is to be located at Ljusne, North Sweden, will be 328 feet in length and of considerable breadth; it will be able to accommodate vessels of 4,000 tons deadweight. The dock has been designed by chief engineer M. Von Eckermann, and will be built on land above water-level. The vessels from the harbour will enter a lock and will then be raised and lifted into the dock by means of water from the water-power canal of the Ljusne face. By this arrangement the dock can be filled and emptied without any pumping plant, and in consequence the cost of docking will be low.

Messrs. William Hamilton and Co. Ltd., Port Glasgow, have just sold their premises known as the "Glen Yard" to Messrs. Russell and Co., shipbuilders, Port Glasgow, a neighbouring firm. By this extension, which is to come into force early next year, Messrs. Russell will be enabled to have berthage accommodation for eight additional vessels of large tonnage, with launching ways right out to the open Firth. By this transfer Messrs. Russell and Co. will become possessed of four of the largest shipbuilding yards in Port Glasgow, this giving them an aggregate constructive capacity of over 30 large vessels, a fact which augurs well for the future prosperity of what is now one of the busiest towns on the lower reaches of the Clyde.

A New Danish Engine.—A Danish engineer has just invented a new steam engine, which, it is stated, will entirely replace the internal-combustion engine. The steam is obtained in the following manner: A pump supplies water intermittently to a coil, where it is vaporised by means of a blowpipe flame. The water circulates in the same way as in a radiator. The engine has three cylinders, but it is stated to be just as efficacious as an internal-combustion engine with six cylinders, whilst, both in weight and size, it is similar to an ordinary petrol engine. The lowest-grade oil may be used as fuel; it is very simple to work, and requires little attention. The engine is especially suitable for use in trawlers, and patents have been applied for in Sweden and Norway.

Messrs. Dick, Kerr and Co. Ltd. have received an order for two 5,000 k.w. turbo-alternator sets and condensing plants for the Union Miniere du Haut Katanga, which is one of the largest copper producers in the world, outside the United States of America, having extensive properties in the Belgian Congo. The turbines will be of the Willans-Zoelly type, operating on steam at 145 lb. per square inch pressure and exhausting into a vacuum of 28 in. (barometer 30 in.) and will carry an overload of 6,250 kw. for two hours. The condensing plants are each designed to deal with 66,000 lb. of exhaust steam per hour and have 10,000 square feet of cooling surface. The turbines will be coupled to Siemens alternators designed for a normal output of 5,000 kw., at 0.9 power factor (5,560 k.v.a.), when supplying three-phase current at 50 cycles and 6,600 volts pressure, and will be capable of carrying overloads of 25 per cent for two hours or 50 per cent momentarily. The ventilating air for these machines will be filtered in dry air filters of the Premier Cooler Company's make; the machines will each be fitted with a direct-coupled 110-volt exciter of the overhung type, and will operate in conjunction with an automatic voltage regulator.

Drawings to be used in damp localities, mines, etc., may have to be water-proofed. For this purpose, J. S. Carpenter recommends in the "Engineering News Record" of September 26th, 1918, a solution of pure gum rubber, as bought in drug stores, in benzene. He puts a piece of rubber, about 4 in. square, in half a pint of benzene, contained in a large jar; the rubber swells to three or four times its bulk, and will be ready for use in 24 hours. The solution is then poured into more benzene, so as to yield a thin liquid that will spread under the brush. With this liquid the drawing is coated on both sides. A thicker solution of the same substance is utilised as adhesive to stick parts of large drawings together; the rubber solution is said to be preferable to starch paste, because the joints of the paper do not crimp out of shape and alignment when made with rubber. If the parts may have to be separated again, a rather stiff paste should be taken. The same solution may also be utilised for cleaning dirty drawings; the solution is poured on the drawing, benzene solvent is mopped off, and the remaining film of rubber is rolled up and used as an eraser. Rubber bands will not answer in the place of gum rubber. and benzene is more suitable than formaldehyde.

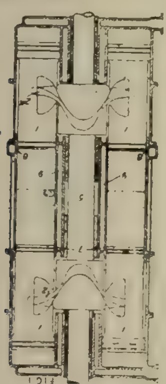
Patent Applications.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

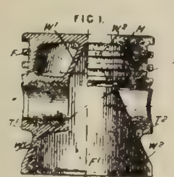
ABSTRACTS OF SPECIFICATIONS.

INTERNAL-COMBUSTION ENGINES.

118,131. W. R. FASEY, The Oaks, Holly Bush Hill, Snaresbrook, Essex. July 10th, 1917. In a stationary-cylinder engine, oppositely-moving pistons compress their pump charges in the closed ends of the cylinders, and the pistons are connected to the driving-shaft through cam mechanism which imparts a dwell to the pistons during the admission periods when the inlet ports are fully open. Fig. 1 shows an engine having a pair of oppositely-moving pistons 1 in each of a number of cylinders disposed parallel to a central shaft 5 having driving-cams 2, 2*a* at its ends. The pistons control inlet and discharge ports 7, 8 respectively, the cams 2, 2*a* being constructed to open, and close partly, the exhaust ports before the opening of the inlet ports, the cams holding the pistons stationary, to prolong the charging period, when the inlet ports are fully-open and the exhaust ports closed. Combustible mixture and scavenging-air may be compressed separately in the closed ends of the cylinders; or combustible mixture only may be used, the charges being stored in a chamber 9 the pressure in which may be regulated as desired. Specification 2249/15 is referred to. According to the Provisional Specification, the cylinders may rotate, and they may contain one piston only.



Patent 118,131.



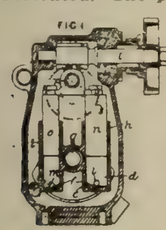
Patent 118,142.

PISTONS.

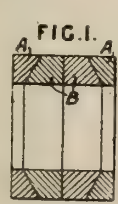
118,142.—G. ROESCH and C. TALBOT Ltd., Barlby Road, Ladbroke Grove, London.—Aug. 11th, 1917.—In a trunk piston, the gudgeon bearings T1, T2 are carried by inclined webs W1, W2, and are also united to the dependent flange F of the head H which carries the packing-rings. The webs W1, W2 are united to the head H, and their edges are connected below the flange F by an extension F1 of the flange. A short cylindrical extension below the extremities of the webs W1, W2 may carry additional packing.

RECIPROCATING PUMPS.

118,159.—E. J. J. SALMSON, 9, Avenue des Moubineaux, Billancourt, Seine, France, and DUDBRIDGE IRON WORKS, Stroud, Gloucestershire.—Aug. 24th, 1917.—A pump for lubricating oil, etc., comprises two oscillating barrels *i*, *h* of different capacities, the larger drawing oil, etc., from a sump, etc., and delivering to a reservoir, the smaller drawing from the reservoir and delivering to the parts to be lubricated. The pistons *o*, *n* have a common cross-head and



Patent 118,159.



Patent 118,189.

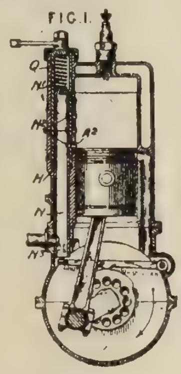
are actuated by a shaft *t* through worm gearing *s* and a crank-pin *r*. The barrels oscillate on a spindle *g* and have ports *l*, *m* adapted to register alternately with suction ports *c*, *e* and delivery ports *d*, *f* in a flat surface over which a flat suface on the barrels works. The pumps are enclosed in a reservoir containing a strainer.

STUFFING-BOXES.

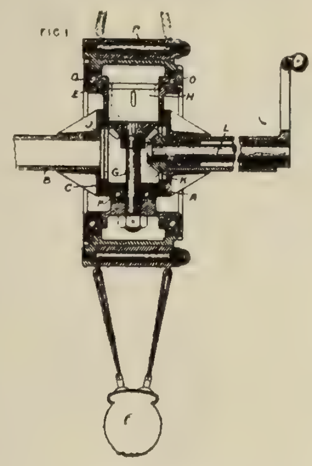
118,189.—J. A. DICK, 51, Fenchurch Street, London.—Oct. 20th, 1917.—Packing comprises a pair of unsplit rings B with bevelled surfaces engaging similar surfaces on outer unsplit rings A. The rings are made of fibre, or of a combination of fibre and metal, and are preferably manufactured in the manner described in Specification 14323/15.

INTERNAL-COMBUSTION ENGINES.

118,144.—K. E. L. GUINNESS, Aranmor, Kingston Hill, Surrey, and C. M. CARINGTON, Glenavon, Bedford.—Aug. 11th, 1917.—A conduit connecting the cylinder of a two-stroke engine to the crank case or other source of supply, to enable a portion of the compressed charge to return to the crank case, is controlled by a reciprocating sleeve valve N working within an adjustable ported sleeve Q, which varies the opening of the ports A2 in the cylinder wall. A port N3 at the lower end of the sleeve N controls the entrance of fresh charge into the crank case. During the explosion stroke, the sleeve N is depressed by a spring N1, closing the ports N2, N3. In a modification, the sleeve N is dispensed with, and the lower part of the conduit H is controlled by ports in the rotating crank-shaft or crank-disc.



Patent 118,144.



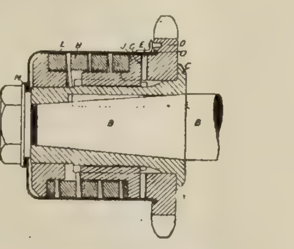
Patent 118,158.

MOTOR VEHICLES.

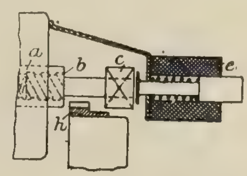
118,158.—W. ELLIS, 7, Shaftesbury Road, Earlsdon, Coventry.—Aug. 20th, 1917.—A single steering-wheel is mounted on a pivoted cylindrical member carried on a fixed hollow axle, the steering being affected by bevel or other gear contained within the axle and the cylindrical member. The cylindrical member E is carried on a member A mounted in brackets C on the hollow axle B. A fitting H is splined to the member E and is provided with a spindle G having a bevel-gear J meshing with a bevel-gear K on a shaft L. The wheel hub P rides on the member E, ball bearings O being provided. A bearing F is also provided between the members A and E. The bevel-gearing may be replaced by a rack and pinion.

CLUTCHES.

118,202.—S. E. ALLEY, 33, Tothill Street, Westminster.—Nov. 24th, 1917.—In clutches of the type in which toothed members engaging under spring pressure are automatically disengaged under excessive load, a sleeve J provided with inclined teeth G slides on a flanged sleeve C secured to the driving-shaft B and is pressed by an adjustable spring H into engagement with similar teeth E on a loose chain-wheel D. A casing L provided with packing M, O excludes dust.



Patent 118,202.



Patent 118,220.

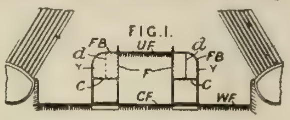
ENGINE TURNING-GEAR.

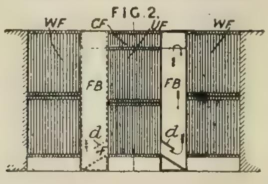
118,220.—H. LUCAS and C. L. BREEDEN, Great King Street, Birmingham.—Jan. 10th, 1918.—An electric starter for motor-vehicle engines comprises a pinion *c* screw-connected with an armature or other shaft *a* and a solenoid *e* adapted to produce axial movement of the pinion relatively to the shaft. In the form shown, the shaft *b* of the pinion is threaded to engage an internal thread in the shaft *a*. The solenoid is preferably in series with the motor, and is cut out by a switch when the pinion is fully in gear with the driven wheel *h*.

STEAM-GENERATOR FURNACES.

118,219.—J. MOUZAKES, 102, Woodchurch Lane, Prenton, Birkenhead, Cheshire.—Dec. 31st, 1917.—In connection with a water-tube boiler, an independent upper grate UF is arranged above the central grate CF and between two air-supply heating boxes FB. These boxes are divided by horizontal partitions *t* extending

from the front nearly to the rear. Air enters at the front below the partitions and passes to the rear, returning to the front above the partitions and being discharged above the fire on the central grate and below that on the upper grate through openings F arranged at an angle, as shown in Fig. 2, in connection

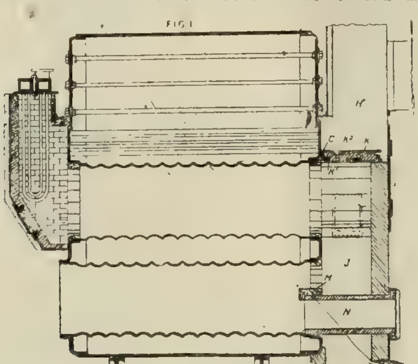




wiht baffles d. The gases from the lower central fire, mixed with hot air, pass through the fire on the upper grate and mingle with the products of combustion rising from the wing fires WF.

STEAM-GENERATORS.

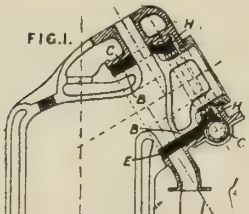
118,223.—INGLIS BOILER SYNDICATE, 83, Renfield Street, Glasgow, and G. INGLIS, Firhill House, Airdrie, Lanarkshire.—May 2nd, 1918.- In the boiler described in Specification 5939/03, the steel internal-combustion chamber is replaced by an external firebrick combustion chamber having a removable top wall dividing the chamber from the smoke-box. The bricks K of the wall



between the combustion chamber J and the smoke-box H are formed with grooves K1 which fit over an angle-iron C secured to the boiler end-plate. A brick may be removed through a smoke-box door L by inserting a gripping-tool in a curved groove K2 in the top of the brick. Ashes are withdrawn through a conduit N extending from the back of the furnace through the combustion chamber, or the bridge M may be carried across the chamber so that ashes may be raked over the bridge into a pit at the back.

INTERNAL-COMBUSTION ENGINES.

118,244.—R. F. D. DONGRIE, 34, Tavistock Square, London.—March 28th, 1918.—A sleeve valve E is inclined to the cylinder axis and rotates between a cover C and a cylinder extension B. The valve has its inlet and outlet ports located in different planes, the number of ports depending upon the speed of rotation of the valve. Rotation of the valve is effected by a worm G engaging peripheral teeth H. The worm G is axially adjustable upon its driving-shaft.



Patent 118,244.

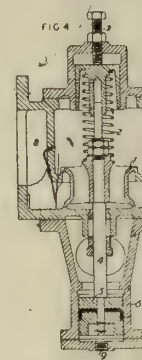
Patent 118,254

INTERNAL-COMBUSTION ENGINES.

118,254.—C. W. SMALL, 17, Barkston Gardens, South Kensington, and B. GOODHEAD, 3, Quarrendon Street, Fulham, both in London.—Nov. 12th, 1917.—Cylinders in which air is compressed in the ends remote from the combustion spaces are disposed co-axially on opposite sides of pin-and-slot driving mechanism. In the engine shown in the figure, three cylinders are arranged on each side of a central crank-shaft u having cranks separated by 120 deg. Air is compressed in the pump spaces and transferred to the combustion chambers through terminal ports 7 at the ends of the suction and expansion strokes. Normal inlet and exhaust valves are provided at 4, 5 in each cylinder; the exhaust valves open after the completion of two-thirds of each firing stroke and the normal inlet valves close slightly before the opening of the air inlet port 7.

AIR COMPRESSORS.

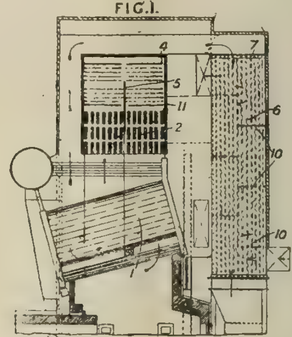
118,258. FULLERTON, HODGART, & BARCLAY, Vulcan Foundry and Engine Works, and W. McGREGOR, 56, Causeyside Street, both in Paisley, Renfrewshire.—May 3rd, 1918.—A two-stage air-compressor has unloading valves operated by receiver pressure acting on pistons on the valve spindles and located on the discharge sides of the low and high pressure cylinders so that each cylinder discharges to atmosphere when maximum receiver pressure is



attained. Each valve 1 is provided with a controlling-spring 2 and regulating-screw 3, and its spindle 4 has a piston 5 in a cylinder 6 to which compressed air from the receiver is admitted past a governor ball, etc., and through a passage 9 when the maximum pressure is reached, the valve 1 then being opened to allow air from the inlet 7 from the high or low-pressure cylinder to exhaust through a branch 8 to the atmosphere. The air passing freely through the cylinders, intercooler, and pipes keeps these cool and well scavenged.

STEAM-GENERATORS.

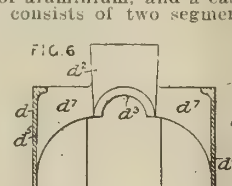
118,310.—BABCOCK & WILCOX and J. KEMNAL, 30, Farringdon Street, London.—Aug. 17th, 1917.—A boiler is provided with a superheater arranged above the boiler proper and with a steam reheater arranged above the superheater. The U-tube superheater 2 and the reheater 4 arranged above a Babcock and Wilcox

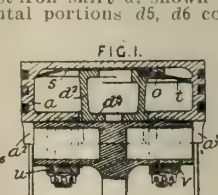


boiler 1 are enclosed by a casing 11 and are provided with a sliding damper 5. The reheater consists of slightly curved tubes connected to side drums. An air-heater consists of a chamber 7 fitted with tubes 6 through which the furnace gases pass on their way to the chimney. Air flows upwards through the chamber around the baffle-plates 10 and then down the side boiler casings to the ash-pit.

PISTONS; CONNECTING-RODS.

118,322.—J. BURNAND, 103, Cambridge Road, Teddington, Middlesex.—Aug. 22nd, 1917.—A piston comprises a head a, Fig. 1, which may be of aluminium, and a cast-iron skirt d, shown also in Fig. 6, which consists of two segmental portions $d5$, $d6$ connected by





flexible webs $d7$ to a hollow central boss $d2$. The latter forms a support for the piston crown and has a bearing $d3$ for the connecting-rod end, which is secured by caps u, v to bearings $a2$, $a3$ on the head a in line with the bearing $d3$. Semicircular plates s, t secured by a semicircular ring o facilitate the conduction of heat and protect the interior of the piston from oil.

— THE —

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EDITORIAL.

BENZOL AND ALCOHOL.

PROBABLY no greater service has been rendered to motor power users and the community generally by the Institution of Petroleum Technologists than in arranging for the paper recently read before them by Dr. Ormandy, on the Fuel Problem. The author is one of our most distinguished scientists, and has given many years to the study of motor fuels, both experimentally and practically. It is almost 20 years since he told the Royal Automobile Club that a time was bound to come when a petrol substitute would have to be found, and, be it remembered, he was speaking at a time when petrol was less than a shilling a gallon. During all the intervening period motorists, and indeed many owners of small petrol engines, have taken their supplies of fuel as a matter of course. From time to time warnings have been issued as to the fool's paradise in which we were living, these warnings usually coinciding with increases in the price of petrol. Nothing was done, for the simple reason that what appears to have been everybody's business was nobody's. And yet, in the midst of it all, we had the head of one of the leading oil concerns telling us that the value of petrol was what it would fetch. All these points were very present to the minds of Dr. Ormandy's hearers as they met to hear his suggested remedy for a state of affairs which is admitted to be fraught with much danger to industry and to the nation.

His main points deal with the two possible and practicable alternatives to petrol, benzol and alcohol. He is a strong believer in the latter solution; not, however, to be used by itself, but in combination with benzol. He does not believe that we should look for its production in this country as a paying proposition; certainly it would not be profitable if crops were to be raised purely for alcohol purposes. It is to sunnier climes that we are to look for the production of this commodity on a large and economical scale, a view that has more than once been put forward in this journal. No amount of argument will make it profitable to grow potatoes either in this country or in Ireland for the purpose of providing a motor spirit. It simply cannot be done. As to its use alone, there has, of course, been abundant experience, as prior to the war there existed thousands of alcohol engines on the Continent, for the most part employed in agricultural work. These were chiefly of the stationary type, having a long stroke and high compression, and designed so that the fuel and air supply could be heated. As to the thermal efficiency, this is higher in the case of alcohol engines than of petrol engines, the fuel consumption per brake horse power being practically equal in the two cases despite the fact that the heat value of the alcohol is not quite two-thirds that of the same weight of petrol. According to this authority, alcohol can be produced within the confines of the British Empire in practically unlimited quantities, but the only immediate way to encourage its use is to use it in admixture with home-produced benzol.

Now, the war has brought about a big production of benzol. Competent authorities say that there will now be available 50,000,000 gallons per annum, not perhaps a very large quantity in view of the big demand for fuel, but, if used as Dr. Ormandy suggests, in conjunction with alcohol, it would make

its influence felt on the petroleum magnates who are closely following all developments. Indeed, if the power users are not careful, it is just possible that the oil ring may buy up the entire benzol production of this country, and, by blending it with their petrol supplies, control the situation and still further enhance their own profits. This ought not to be allowed, and it is the manifest duty of the Government to see that nothing of the kind happens. Unless something is done, it is hardly likely, said the author, that the producers of 50,000,000 gallons per annum of motor benzol can hope to control prices with a demand for motor fuel of 200,000,000 gallons. The petrol people have, it should be borne in mind, a highly-organised scheme for distribution, and it would be no difficulty to them to take over benzol in the manner indicated. It is hoped that it will not come to this, but, obviously, there should be no delay, as once the benzol supply gets into the hands of the petroleum people, the chance for the development of an alcohol industry is retarded, and progress made impossible for years.

Dr. Ormandy points out that the by-product coke-ovens in this country are for the most part owned by wealthy colliery and iron and steel firms, who are quite capable, from the financial side, of handling the benzol proposition, but the crux of the problem for them lies in the distribution. As to developing this source of fuel, no imaginable increase in any of the industries that lead to the production of motor benzol can conceivably give an increased yield which will keep pace with the ordinary growth of motor fuel requirements. As regards gas works, it is certain that the utilisation of coal gas in industrial and heating operations will continuously grow, and in so far as this is the case, there will be an increased output of motor benzol. Dr. Ormandy is of the opinion that it is to the better utilisation of hitherto neglected low-grade cannel and other coals that we must look for additional outputs. As to the production of benzol from the coke-oven, this is primarily dependent on the growth of the iron and steel industry, and whether with the coke-ovens installed there shall be put down benzol recovery plant depends upon the market value of the product. We are told that as regards coke-oven benzol, this, in the eyes of the steel world, is a very minute by-product, and that no variation in price will have any appreciable influence upon the amount manufactured.

There is no doubt in Dr. Ormandy's mind that it is a national duty that adequate experiments should be carried out with a view to discovering the proper method or methods for obtaining from low-grade fuels the utmost values contained in them, and it is to be deprecated that the interest recently aroused in this subject should have met with so little support. The paper, of which this is necessarily a brief review, ought to bring home to the authorities their responsibility in this matter; not to power users alone, but to the community generally.

Between 6th April, 1917, the date of the declaration of war by the United States, and 11th November, 1918, the date of the armistice, merchant vessels built in the United States and officially numbered by the Bureau of Navigation, Commerce Department, including also those built for the Allies or for neutral nations, numbered 2,985 of 3,091,695 gross tons, of which 506 of 2,056,814 gross tons were ocean steel steamers.

THE COAL SHORTAGE.

The Coal Controller's Monthly Figures.

The monthly return issued by the Coal Controller shows that during the first 44 weeks of the year there was a further serious falling off in the estimated output of coal compared with the corresponding period of last year.

The net shortage is 17,679,600 tons, or about 8.3 per cent.

Period.	Output of Coal. 1918.	1917.
1st four weeks ended Feb. 2nd, 1918	18,826,700	20,430,600
2nd ,, ,, ,, Mar. 2nd, 1918	19,141,600	19,881,500
3rd ,, ,, ,, Mar. 30th, 1918	18,759,700	19,840,400
4th ,, ,, ,, Apl. 27th, 1918	17,698,400	18,659,200
5th ,, ,, ,, May 25th, 1918	16,856,800	20,092,600
6th ,, ,, ,, Jun. 22nd 1918	17,791,800	18,727,300
7th ,, ,, ,, July 20th, 1918	15,780,300	18,982,800
8th ,, ,, ,, Aug. 17th 1918	16,042,200	17,769,200
9th ,, ,, ,, Sep. 14th, 1918	17,767,000	19,502,600
10th ,, ,, ,, Oct. 12th 1918	17,893,800	19,163,500
11th ,, ,, ,, Nov. 9th, 1918	17,762,800*	18,951,000
	194,321,100	212,000,700
		194,321,100
Deficiency		17,679,600

* Provisional.

It will be observed that for the four weeks ended 9th November it is estimated that 17,762,800 tons of coal were raised at mines in the United Kingdom as against 18,951,000 tons during the corresponding period of 1917—a shortage of 1,188,200 tons.

In the first period allowance should be made for the prevalence of sickness amongst the workpeople and for the celebration of the armistice at collieries. Making the best practicable estimate for the loss of time in each period due to holidays, disputes, accidents, etc., and for changes in the numbers employed the capacity of the industry during the four weeks ended 9th November this year was about 12 per cent, or 625,000 tons per week, less than in November, 1917. As compared with the previous four weeks ended 12th October, 1918, the capacity of the industry was slightly less in the four weeks ended 9th November.

Since the end of last March, the stocks of coal held at mines and in trucks have been reduced to the extent of over $1\frac{1}{3}$ million tons approximately.

Notable improvements were shown in the number of days worked by the mines in the following counties compared with last year:—

	Days per week.		Days per week.
Monmouth	1.52	Carmarthen	.54
Durham	.83	Northumberland	.45
Glamorgan	.74	Fife and Kinross	.44
Pembroke	.68	Haddington	.41

A scholarship designated the "Elgar Scholarship in Naval Architecture" will be offered for competition among students of the Institution of Naval Architects in 1919. All students (being British subjects) who have been elected at or before the annual general meeting of the Institution (April 9th, 1919) will be eligible for this scholarship. The scholarship is of the annual value of £100, and is tenable for three years. A prize of books or instruments to the value of £5, offered by the Earl of Durham, will be awarded by the Council to the candidate next in order of merit to the winner of the scholarship or to such other competitor as, in the opinion of the Council, may deserve the award. All communications with respect to the scholarship should be addressed to the Secretary of the Institution of Naval Architects, 3, Adelphi Terrace, London, W.C.2.

ON THE DETERMINATION OF THE TEMPERATURE RISE OF OIL CIRCUIT BREAKERS.

By G. E. GITTENS, B.Sc. (Lond.).

(Continued from page 117.)

Heating Curves.

When a body of given thermal capacity and radiating surface is uniformly heated, the temperature rise above the surrounding air (assumed constant) follows a logarithmic law, and may be expressed by

$$\theta = \theta_m \left(1 - e^{-\frac{t}{T}}\right)$$

where t = time from start,
T = heating time constant,
e = base of natural logarithms.

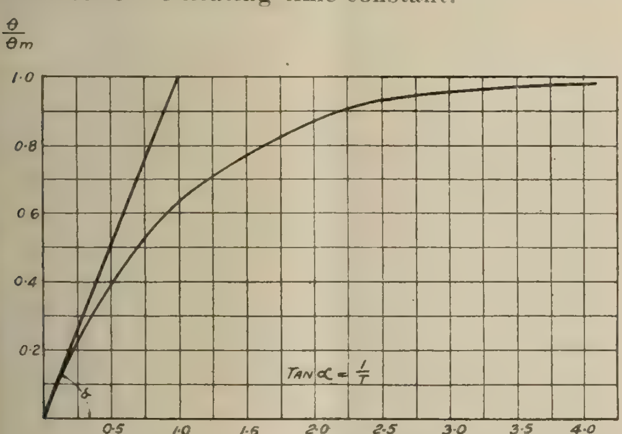
If we plot the relationship between $\frac{\theta_m}{\theta}$ and $\frac{t}{T}$ we get the curve shown in Fig. 2*a*. It will be noticed that for a value $\frac{t}{T}$ = 4 the curve approaches asymptotically a line drawn through $\frac{\theta_m}{\theta}$ = 1 parallel to the $\frac{t}{T}$ axis; that is, the time to practically reach a stationary temperature = 4 × heating time constant. Important results may be deduced from the curve whose equation is—

$$\theta = \theta_m \left(1 - e^{-\frac{t}{T}}\right)$$

Differentiating θ and t, we get

$$\frac{d\theta}{dt} = \frac{\theta_m}{T} e^{-\frac{t}{T}}$$

which gives the slope of the curve for any value of t. Now, at start $t = o$, and $\frac{d\theta}{dt} = \frac{\theta_m}{T}$. The interpretation is that the tangent to the curve at the origin is measured by the ratio of the maximum temperature rise to the heating time constant.

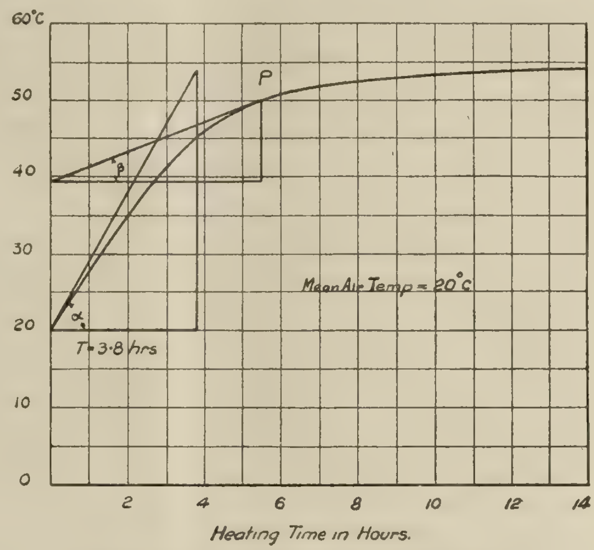


DETERMINATION OF TEMPERATURE RISE.—FIG. 2A.

Consequently, if we draw a tangent to the heating curve at the origin, produce the tangent until it meets the horizontal through the maximum temperature rise on the ordinate scale, and then project this point of intersection upon the time co-ordinate axis the intercept between the foot of the perpendicular and the origin gives the heating time constant. [Refer to Fig. 3, which is a curve taken on an actual switch.] If, then, we know T, we can predict approximately the time it will take for the switch under given load conditions to reach a stationary temperature.

By aid of the heating curve we may also find the rate of cooling at any specified temperature rise.

Thus, turning to Fig. 3, suppose we require the



DETERMINATION OF TEMPERATURE RISE.—FIG. 3.

rate of cooling at 30 C° rise above air for our switch, we proceed as follows:—

The tangent to the curve at the origin gives the rate of increase of temperature at start when radiation is zero, since the switch is at air temperature. The tangent at P gives the rate of increase in temperature when the temperature rise is 30 C°. If, then, we subtract the slope at P from the slope at O, we get the rate at which the switch is cooling.

$$\text{Thus } \tan \alpha = \frac{34 \text{ C}°}{3{\cdot}8 \times 60 \text{ min.}} = {\cdot}149 \text{ C}° \text{ per min.}$$

$$\text{and } \tan \beta = \frac{10{\cdot}5 \text{ C}°}{5{\cdot}5 \times 60 \text{ min.}} = {\cdot}0318 \text{ C}° \text{ per min.}$$

Hence rate of cooling at P

$$= \tan \alpha - \tan \beta$$
$$= ({\cdot}149 - {\cdot}032) \text{ C}° \text{ per min.}$$
$$= {\cdot}117 \text{ C}° \text{ per min.}$$

Cooling Curves.

If a hot body be allowed to cool, the ambient temperature remaining constant, the temperature difference of the body follows a law which may be expressed—

$$\theta = \theta_o e^{-\frac{t}{T}}$$

Where θ_o = temperature difference at start of cooling period
θ = temperature difference after a time "t"
and T = Heating time constant.

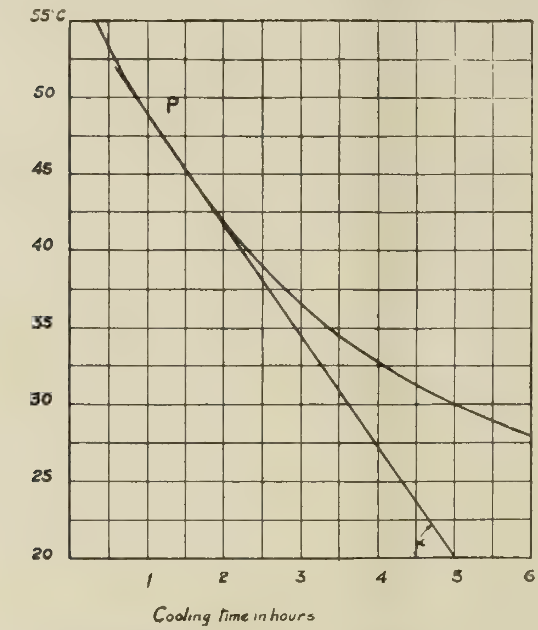
Diffentiating θ with respect to t we get

$$\frac{d\theta}{dt} = \frac{\theta_o}{T} e^{-\frac{t}{T}}$$

Putting $t = o$, then $\frac{d\theta}{dt} = \frac{\theta_m}{T}$

that is, the rate of cooling, at a temperature difference θ_o is equal to this temperature difference divided by the heating time constant. In other words, the rate of cooling of a hot body is propor-

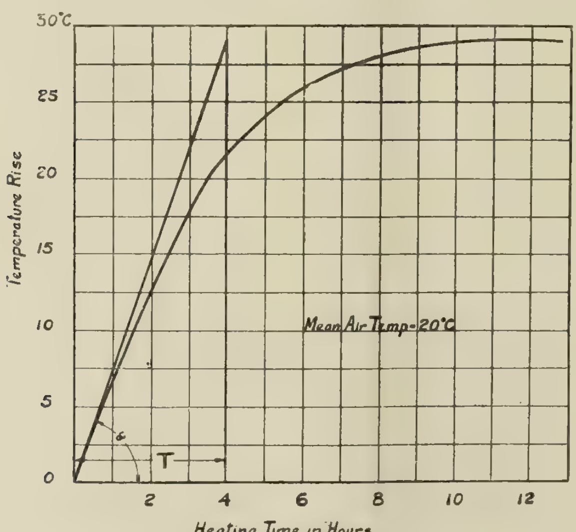
tional to the mean difference of temperature between the body and the ambient air. This is known as Newton's law of cooling, and whilst not correct for large temperature differences, it is sufficiently exact for oil switch purposes. We may here remark that the designer should always obtain the cooling curves



DETERMINATION OF TEMPERATURE RISE.—FIG. 4.

for his switches when on test as a check on his calculated losses.

Fig. 4 gives the cooling curve for a heavy current, large breaking capacity switch. The stationary temperature on this switch was 49 deg. Cen. If we



DETERMINATION OF TEMPERATURE RISE.—FIG. 5.

draw a tangent to the curve at P corresponding to 29 C° rise, then tan α gives the rate of cooling at 49 deg. Cen. Now

$$\tan \alpha = \frac{29\ \text{C}^\circ}{240\ \text{mins.}} = \cdot 12\ \text{C}^\circ \text{ per min.}$$

If then we know the effective thermal capacity of the switch, we get at once the watt loss at the particular load, since when the temperature is stationary the rate of cooling must be equivalent to the rate at which heat energy is generated in the switch. For this particular switch the calculated effective thermal capacity is 34,000 calories per C°, and hence the watt loss

$$= 34{,}000 \text{ cal. per C}^\circ \times \cdot 12\text{C}^\circ \text{ per min.}$$
$$= 408 \text{ cal. per min.}$$
$$= \frac{408 \times 4\cdot 2 \text{ joules}}{60 \text{ sec.}}$$
$$= 286 \text{ watts.}$$

Also from the curve figure 5, $\tan \alpha = \frac{\theta_m}{T}$, whence the heating time constant = 4 hours, and therefore the rate of cooling at 49°C is

$$\frac{\theta_0}{T} = \frac{29\ \text{C}^\circ}{240 \text{ min.}} = \cdot 12\ \text{C}^\circ \text{ per minute,}$$

which agrees with the value taken from the cooling curve for the switch.

Another useful expression for the rate of cooling is

$$\frac{d\theta}{dt} = \frac{T}{M}(c^{t_1} - c^{t_2}) \text{ where}$$

T = Heating time constant in seconds,
M = effective thermal capacity in calories per C°.
c = a constant = 1·008.
t_1 = temperature of hot body,
and t_2 = temperature of ambient air.

Inserting our values :—

$$c^{t_1} = 1\cdot 008^{49} = 1\cdot 451$$
$$c^{t_2} = 1\cdot 008^{20} = 1\cdot 164$$
$$\therefore c^{t_1} - c^{t_2} = \cdot 287$$

Also $\frac{T}{M} = \frac{14400}{34000} = \cdot 424$

Whence $\frac{d\theta}{dt} = \cdot 424 \times \cdot 287 = \cdot 122.$

(To be continued.)

ON RAPID METHOD OF ESTIMATING PHOSPHORUS IN BRONZES.*

By T. E. ROONEY, A.M.S.T.

BRONZE drillings, to the amount of from 0·5 grm. to 2 grm., are dissolved in a mixture of 20 c.c. strong nitric acid and 10 c.c. strong hydrochloric acid, or, if preferred, 60 c.c. nitric acid (specific gravity, 1·135), and 10 c.c. hydrochloric acid. The mixture is digested for some time without boiling until most of the red fumes have been evolved. If the concentrated acids are used the mixture is then diluted to about 70 c.c. The liquid is next cooled and 40 c.c. of ammonia (specific gravity, 0·96) added slowly with constant shaking, followed by 35 c.c. of nitro-molybdate solution, and the whole shaken well for a few minutes. The mixture is allowed to stand for one to two hours until the precipitate has settled out, when it is filtered, preferably on pulp, washed with water until free from acid, the filter and precipitate transferred back into the flask, excess of N/20 caustic soda run in from a burette, the whole well mixed and the excess of caustic soda titrated with N/20 sulphuric acid, using phenolphthalein as in an indicator.

* Paper read before the Institute of Metals.

1 c.c. N/20 caustic soda = 0·00337 per cent P on 2 grm.

The method is based on the well-known volumetric method of estimating phosphorus in steel. It is best carried out in a 600 c.c. conical flask and a rubber stopper used in the final shaking.

POINTS.

1. The digestion with acid must be long enough to oxidize all the phosphorus, or results will be low.

2. Boiling or heating must not be too prolonged or tin will be precipitated and will be difficult to redissolve.

A comparison of the method has been made with a gravimetric method, in which the tin oxide containing the phosphorus is mixed with Hepar mixture and fused. The resulting melt is dissolved in hot water, the solution acidified with a little hydrochloric acid whereby the tin is precipitated.

The tin sulphide is allowed to settle, and is then filtered off, the filtrate being boiled to remove sulphuretted hydrogen; nitric acid is added and taken down to low bulk, and the phosphorus precipitated and estimated as magnesium pyrophosphate in the usual way.

The results obtained by the two methods on a number of commercial bronzes are given in the accompanying table along with the approximate composition of the bronzes.

TABLE SHOWING RESULTS OBTAINED WITH DIFFERENT SAMPLES OF COMMERCIAL BRONZE BY RAPID AND GRAVIMETRIC METHODS OF ANALYSIS.

Copper.	Tin.	Lead.	Zinc.	Iron.	Phosphorus.	
					Gravimetric.	Volumetric.
88·32	2·56	8·08	0·11	0·24	0·45	0·42
88·30	2·59	8·06	0·11	0·24	0·39	0·41
88·59	10·63	..	0·06	..	0·80	0·81
88·57	10 65	0·02	0·14	..	1·43	1·40
88·92	10·00	..	0 18	..	0·76	0 74
77·31	10·30	10·45	0·10	..	1·45	1·44
88·95	2·07	8·24	0·16	..	0·44	0·42
93·73	6·07	..	..	..	0·17	0·18
89·60	2·41	7·76	..	..	0·39	0·37
88·59	10·14	..	..	..	1·24	1·22
88·58	10·37	0·06	0·88	.	0·011	0·010
78·05	8 76	12 48	0·24	..	0·43	0·44

The author wishes to express his thanks to Sir Richard T. Glazebrook, C.B., F.R.S., Director of the National Physical Laboratory, for permission to publish this Note, and to Mr. P. G. Ward, B.Sc., for assistance received.

COAL ECONOMY: FACTS OF INTEREST TO MILL ENGINEERS.

By Mr. W. M. MILES, of the Board of Trade.

MOST people are aware that in every industry utilising energy originally derived from coal or its products, in which category is included practically every manufacturing process in the country, great waste not only can, but does take place; the waste varying with the amount of care and attention that is given to its economical use in the various works and processes carried on.

During the present trying time, efficiency has, in many cases, had to be sacrificed to output, and considerations of losses and waste have had to be put aside as being of less importance than greater output.

This has happened with hundreds of firms throughout the country, and, consequently, the waste of fuel, which was very great even in the normal pre-war times, has been multiplied enormously during the trying times of the past four years; to such an extent has this occurred, that the Government have had to take notice of it, and experts have been appointed with a view of helping, assisting, and educating manufacturers and domestic users in the essential matters of economical use.

Everyone Should Study Coal Economy.

The schemes put forward have done a great amount of good, but much still remains to be done, especially at the present time when the great shortage threatens to be so acute in the coming years. It thus behoves everyone to study economy in its use, and where possible to utilise coke or poorer quality fuel to meet their requirements, and thus release coal of higher calorific value and better quality for more important undertakings, whilst works in which the coal has been burnt inefficiently, thereby using more coal than was necessary for their requirements, will be rationed with a reasonable amount of suitable fuel, and will have to make that quantity suffice for their actual needs.

Every separate plant requires individual investigation, and the Coal Controller is well aware of these great difficulties, and appeals to the staffs of these undertakings to make the necessary investigation and overhaul required to render their plants more efficient, and thus, not only keep the Government scheme, but make their own working costs lower, and incidentally help materially to save our national assets.

Hearty Co-operation of Managers and Employees.

Naturally, this is not a case for managers and officials only to be become efficient, they must have the hearty co-operation of all the firms' employees, and there should be a mutual understanding between the management and the workmen, before any satisfactory plan of saving can be carried out with real success, and to this end every man should be encouraged to express his ideas and suggestions for general methods of improvement in working, for although it is probable that some 95 per cent of the ideas put forward will be impracticable, there are sure to be a few which will contain a germ of good, and some of them may lead to a big saving.

We must also bear in mind the fact that, at the present time, we have had to replace the men for army purposes by other labour, drawn from all sources, and generally with no knowledge at all of the work that is required. In consequence of this, works which were not very efficient before the war are now probably more inefficient still, and it is up to the responsible management to teach this raw labour what is required of them before expecting to obtain as good or even better results than those obtained from the old and more experienced staff, and to help forward this knowledge is the primary reason for the preparation of this lecture.

Obtain all Heat Possible from Fuel.

In works and factories, coal is a means of producing power, and the chief aim in all the works using coal as fuel is, or should be, to obtain all the heat possible out of the fuel, and convert it into useful work.

The coal we are using to-day is composed of the decayed vegetation which covered the earth thousands of years ago, and we must bear the fact strongly in mind that, once used it cannot be replaced, and the time is approaching when our assets of this valuable mineral will approach exhaustion, and, therefore, it behoves us to use it with the greatest care.

Coal is chiefly composed of water, hydrogen, carbon, sulphur, nitrogen, oxygen, and ash. They have each properties and peculiarities which present themselves, and these, if not studied carefully, may result in unnecessary loss.

Water.

Water or moisture is always found in coal. It is combined with the seam, but on being mined and brought to the surface, begins to vary more or less according to the humidity of the atmosphere. Some, of course, picks up free moistures through exposure to heavy rains whilst in transit, and washed coals are often sent out with more than the specified amount of water. In any case, water means loss; and besides being an expensive diluent, it uses heat from the coal in being converted into steam, which leaves the chimney with the exit gases without giving up the latent heat absorbed.

Hydrogen.

Hydrogen is a combustible gas which gives out great heat; 1 lb. of hydrogen burnt completely with oxygen, generates about 62,100 B.Th.U's. This amount, however, is not fully realised, because, in burning, water is formed, and this, like the water or moisture already described, escapes with useful heat up the chimney at the expense of that in the coal.

Carbon.

Carbon is the most useful element found in coal; it varies from about 50 per cent in lignites to about 95 per cent in anthracite.

When carbon is burnt on a boiler grate, combustion takes place in three stages, which take place at No. 1 (directly above the bars), No. 2 (incandescent carbon in middle of fire), No. 3 (immediately above bed of fuel).

No. 1 ..	C	+	O2	=	$C.O._2$
	Carbon		Oxygen		Carbon-dioxide.
No. 2 ..	$C.O._2$	+	C	=	2.C.O.
	Carbon-dioxide		Carbon		Carbon-monoxide.
No. 3 ..	2.C.O.	+	O_2	=	$2.C.O._2$
	Carbon-monoxide		Oxygen		Carbon-dixoide.

1 lb. of carbon burnt completely to $C.O._2$ generates 14,760 B.TH.U.'s.

1 lb. of carbon monoxide burnt to $C.O._2$ generates 4,480 B.TH.U.'s.

It will be seen from the equations and data given, that a shortage of air between No. 2 and No. 3 will result in loss, due to some CO. leaving in an unburnt state; besides the oxygen supplied at the bottom of the grate, there must be an excess of air supplied either through the bed of fuel, or above it, to burn the CO. and volatile hydrocarbons given off, before the maximum amount of heat is derived from the combustion of the fuel.

1 lb. of carbon-monoxide in the exit gases means a loss of 14,760 − 4,480 − 8,960 B.Th.U's. (or 1 per cent of CO. in exit gases means about 9 per cent loss of heat.

Sulphur.

Most coals contain a little sulphur. In some coals, however, compared with carbon or hydrogen; we high percentages of ash or ironstone. Sulphur also burns with oxygen and gives up heat, not very much, hoever, compared with carbon or hydrogen; we would be better without sulphur, as it is the cause of a lot of trouble.

When sulphur burns, it causes a choking kind of gas called sulphur dioxide, and this, together with steam from the water in the coal and water formed by the burning of hydrogen, forms a weak acid, which causes corrosion on the fire side of the boiler and economiser tubes, where the temperature is sufficiently low enough for moisture or weak acid to be deposited.

Nitrogen.

Coal generally contains a little nitrogen. This in its pure state is a gas, but unlike carbon, hydrogen, and sulphur, it does not burn, gives up no heat, so is no good for steam raising. In gas works and by-product recovery plant, however, nitrogen in coal is very useful; it is used for making ammonia, and, by the addition of sulphuric acid, ammonium sulphate, a very useful fertiliser, is made.

Oxygen.

Oxygen is also found in coal; it does not give up any heat unless there is some combustible matter present. It is like the oxygen in the air; it only supports combustion.

Care must be taken, therefore, that sufficient air containing it is supplied to the fuel, so that no CO. or unburnt hydrocarbons escape without giving up their complement of heat.

Air Contains.

By weight 23 per cent oxygen, 77 per cent nitrogen.

By volume 20 per cent oxygen, 80 per cent nitrogen.

Ash.

All coals contain ash, which is due to the mineral matter being present when the seam of coal was formed. When coal is stored in the open for any length of time, it loses a fair amount of its useful properties, due to oxidation taking place, or, what is usually termed weathering. This has the effect of increasing the amount of ash, and naturally lowers the heating value; to overcome loss due to storage, complete immersion in water is best, as this is now being carried out by several large firms in the States and also in this country.

Ash is an important item when purchasing coal. It is like water, because it is paid for without giving up heat; is worse than water, because when dumped from a boiler furnace can take anything from 3 per cent to 30 per cent to waste in the form of unburnt fuel.

When a chemist tests coal in his furnace, he burns off all the combustible matter, leaving pure ash, which usually has a colour between light yellow and dark red. To obtain the same results in a boiler, however, is practically impossible, and there is

always more ash returned from a boiler than obtained by the chemist when testing in his laboratory.

Suppose a fireman gets 24 per cent of ash from his boiler, and a chemist, on testing the same coal, found 17 per cent; what is the reason? It is quite evident the fireman cannot get more pure ash than the chemist, but he can, when careless, get a larger amount of a mixture of ash and unburnt fuel.

Assuming the difference between 24 per cent and 17 per cent, that is, 7 per cent to be unburnt fuel in the form of unburnt carbon; what is the loss? Suppose 1 lb. of the coal burnt contained 11,000 B.Th.U's.

$$\text{Then loss} = \frac{\cdot 07 \times 14{,}600 \times 100}{11{,}000} = 9 \cdot 3 \text{ per cent.}$$

That is, out of every 100 parts of heat in the coal, more than 9 are wasted. It is serious, still there are works throughout the country more or less inefficient; works where coal or ash cannot be tested, or where no check on boiler efficiency or coal consumption can even be ascertained. Steam or energy is required, and coal is burnt wastefully, regardless of what a little thought or coaching might do.

What does this 9 per cent loss mean? Suppose a certain works burnt 100 tons a week, and in doing so entailed actually a 9 per cent loss, now with the best of staff, and boilers in the very best condition, there is always a certain amount of fuel lost, which averages about 3 per cent, so that virtually there is 6 per cent loss to be recovered. Therefore, assuming 6 per cent to be correct, the following are the losses with various amounts of coal:—

Amount of coal used, tons.	Loss per cent.	Loss tons.	Amount that should have been necessary, tons
100	6	6	94
200	6	12	198
300	6	18	282
400	6	24	376
500	6	30	470
1,000	6	60	940
2,000	6	120	1,880
3,000	6	180	2,820
4,000	6	240	3,760
5,000	6	300	4,700
10,000	6	600	9,400

This waste does not occur with one class of boiler only, and no matter what type of grate is used, it chiefly depends on the human element, because all grates do more or less what is claimed for them when worked properly.

The chain grate stoker, which in proper hands is very efficient, can be responsible at times for a fair amount of loss; perhaps the man in charge has fires too thick, or not enough air to burn the coal, and, consequently, if the conditions are such that the grates cannot be eased up, unburnt fuel goes over the back end, where later it is dumped without being burnt off. In some works a fair amount of riddlings or small coal finds it way through the bars to mix with the ashes, which is further loss.

With the underfeed stoker there is also loss, which can be more or less considerable when men without the proper instructions are placed in charge. Very often when dumping takes place, they drop the door with the ash on, but spoil matters by putting a slice along the bars and pulling over another foot of coal, which is removed as ash; whereas, if they would dump as usual, then close the door, and pull this foot of coal previously wasted over the bars dumping door, thereby stopping cold air getting in, much saving would ensue; they would not chill the furnace, but would keep the temperatures across the boiler normal.

Regarding waste fuel in ash, it is very difficult a a glance to say whether ash is good or bad. A convenient and good way of testing is to take a sample of ash, crush it fairly small, then powder it by grinding it in a small mill. This sample can then be matched with standard samples containing known percentages of ash and carbon. Say samples varying from 50 to 100 of pure ash, by increments of five per cent, the colour of which varies from the colour of the pure ash, to that of powdered coal.

Clinker may look very good in an ash-pit, some better than others. Some coals, however, run, and, in doing so, manage to enclose small pieces of coal or unburnt fuel. This, when powdered, instead of showing a reddish powder, leaves one varying from slate to nearly the colour of powdered coal, which shows carbon to be present. The amount could be found by matching with standards prepared, and noting the most suitable value.

Suppose this ash is put in a tube and is found to be equal in colour to one containing ash 75 per cent, carbon 25 per cent, then for every 100 tons of ash sent out, 25 tons would be waste carbon, 1 lb. of which contains 14,760 B.Th.U's.

(To be continued.)

THE USE OF POWDERED FUEL FOR HEATING METALLURGICAL FURNACES AND FOR STEAM RAISING.

By J. S. Atkinson,

of the Powdered Fuel Plant Co. Ltd., London.

(Concluded from page 112.)

The Application of Powdered Fuel to Steam Boilers.

Little progress has been made in this country during recent years in connection with the use of fuel in a pulverised form under steam boilers. A few installations have been put in, but the results obtained have not been particularly reassuring. The reason for this limited success is, in our opinion, due to the conditions governing the application of powdered fuel not being fully understood.

In the United States of America far more attention has been given to this subject, and experience has proved that most satisfactory results can be obtained; there is, in fact, every reason to believe that this method of firing boilers will supplant, to a great extent, others where coal is employed as fuel.

Essential Conditions.

In using powdered coal, the following are the principol and essential conditions ensuring success: The coal must be pulverised to an exceedingly fine state. Before burning, the coal must be dried so that a very small percentage of moisture is carried either in a combined or free state. The powdered coal and air for combustion must be intermittently

mixed before combustion takes place. Complete combustion must have taken place before the flame is allowed to impinge on the heating surfaces of the boiler. The combustion chamber must be of suitable size to deal with the maximum quantity of fuel to be burnt.

Judgment must be used in the selection of fuel. Generally speaking, fuels high in volatiles and containing ash with a low fusion point are most suitable. The percentage of volatile matter contained is not, however, a determining feature, as anthracite coal has been efficiently burnt in the powdered form.

The air for combustion must be supplied to the fuel burners at the correct velocity and pressure. Too high velocity will cause the rapid deterioration of the refractory lining as well as causing other trouble.

The powdered coal must be supplied to the fuel burners at a uniform and constant rate.

There are other rather less important conditions to be taken into consideration, but the above are the principal.

If properly applied, the following are the advantages resulting from the use of powdered fuel:—

(1) Fuel Economy.

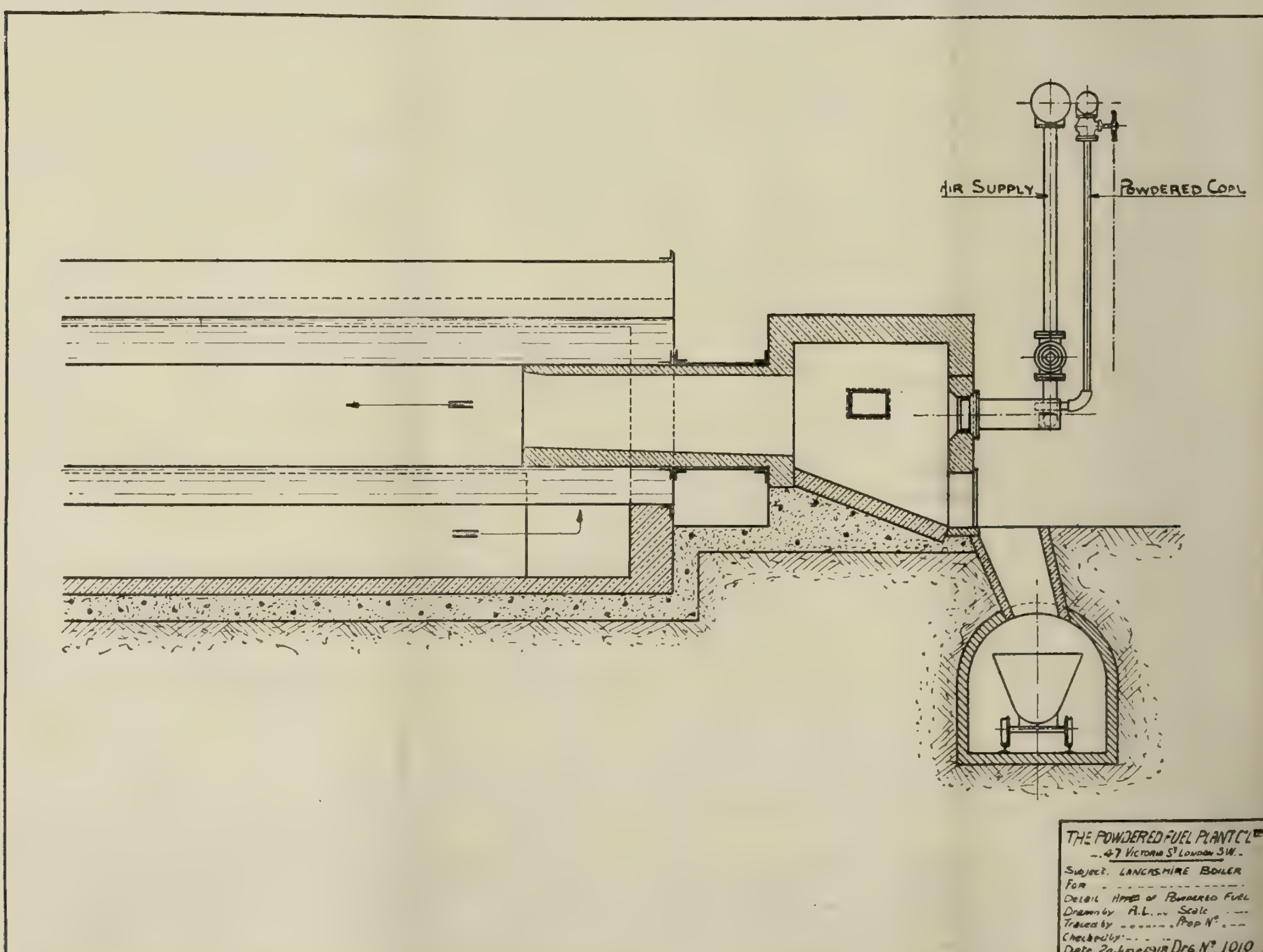
Perfect combustion of the fuel with the minimum amount of excess air can be obtained, resulting in great economy of fuel and high working temperatures. The table given below was prepared by Mr. H. R. Barnhurst, Chief Engineer to the Fuller Engineering Co., and is the temperature of combustion of carbon with varying amounts of excess air.

CALCULATED TEMPERATURES ATTAINED IN BURNING CARBON.

Excess air per cent.	Centigrade. Deg.	Fahrenheit. Deg.
0	2199	3990
10	2064	3747
20	1941	3526
30	1834	3333
40	1734	3153
50	1650	3002
60	1565	2849
70	1496	2725
80	1426	2599
90	1364	2487
100	1307	2345
110	1256	2293
120	1203	2197
130	1151	2109
140	1106	2023
150	1080	1976

Moisture not considered.

With hand-firing 100 per cent and above excess air is required. With mechanical stokers, about 50 per cent excess air is required. Complete combustion can be obtained with powdered fuel with 25 per cent excess air, and, if properly controlled, this excess can be reduced to practically zero. Each minute particle of powdered fuel is surrounded with its requisite belt of air for combustion.



As complete combustion can be obtained in burning powdered fuel, there is no loss due to partially consumed fuel being taken away with the ashes.

With powdered fuel-fired boilers there is no banking up of fires and a further economy of fuel results from this.

(2) Rapid Steam-Raising.

The full temperature of combustion is obtained immediately the boilers are started up; therefore, with powdered fuel, steam can be raised much more quickly than with hand firing or with mechanical stokers.

(3) Labour Saving.

A very considerable saving is effected in labour. One man can look after a large pulverising plant, and very little attention is required at the boilers, as it is only a question of regulating the fuel burners to suit the varying loads.

Also as regards ash handling, a considerable saving is shown here, as the bulk of the ash contained in the fuel passes away in the form of minute particles up the stack, these ash particles having the appearance of a grey vapour.

No strenuous labour is involved, as in the case of hand-fired boilers.

(4) Overloads.

Boilers fired with powdered fuel can be run at 200 per cent rating, with most efficient results.

(5) Fluctuating Loads.

Fluctuation in loads can be met by the simple regulation of the fuel burners.

(6) Law-Grade Fuels.

It is possible to burn economically in the powdered form, many low-grade fuels which could not be utilised either with mechanical stokers or by hand-firing. There are many sources of supply available in this country of fuels which have at present little or no commercial value, as they cannot at present be utilised in the ordinary way; such grades of fuel may, very often, be just what is required for burning in the powdered form.

(7) Smokeless Combustion.

Smokeless combustion is obtained; this should be of considerable advantage, especially in large towns.

(8) New Installations.

The first cost of new boiler installations may very often be appreciably reduced owing to the fact that as powdered fuel-fired boilers can be run at 200 per cent rating economically, the size and number of boilers can be reduced, this, of course, also reduces the cost of construction of the boiler houses. In this statement, the first cost of the pulverising plant is taken into account.

(9) Conversion of Existing Installations.

Any boiler installation can be converted for use with powdered fuel.

One application of powdered coal firing is shown by accompanying sketch.

(Concluded.)

MODERN STEAM TURBINES.

By J. Humphrey.

(Continued from page 104.)

A section of a Willans disc and drum turbine is shown in Fig. 73, where A is the main governor; B, the high-pressure throttle valve; C, the steam chest; D, the nozzle plate; E, the velocity wheel, which deals with the steam emerging from the nozzles; F, the drum; G, the space containing the fixed and rotating reaction blades; H, a connecting pipe admitting condenser pressure to the annular space J, in order to balance the end thrust due to the steam acting on the reaction blades; I, the impulse blading; L, the main bearings; M, the

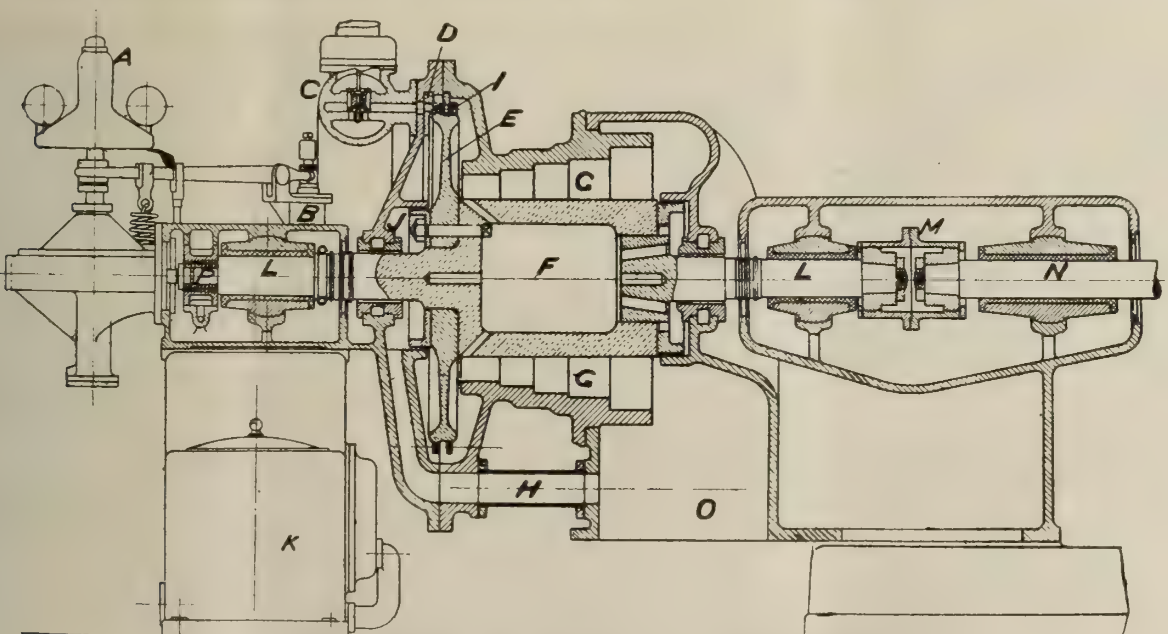


Fig. 73.—Willans and Robinson's Disc and Drum Turbine.

flexible coupling; N, the generator main bearing: O, the exhaust chamber leading to the condenser: and P, the small thrust bearing which adjusts the position of the rotor. This drawing shows a high-

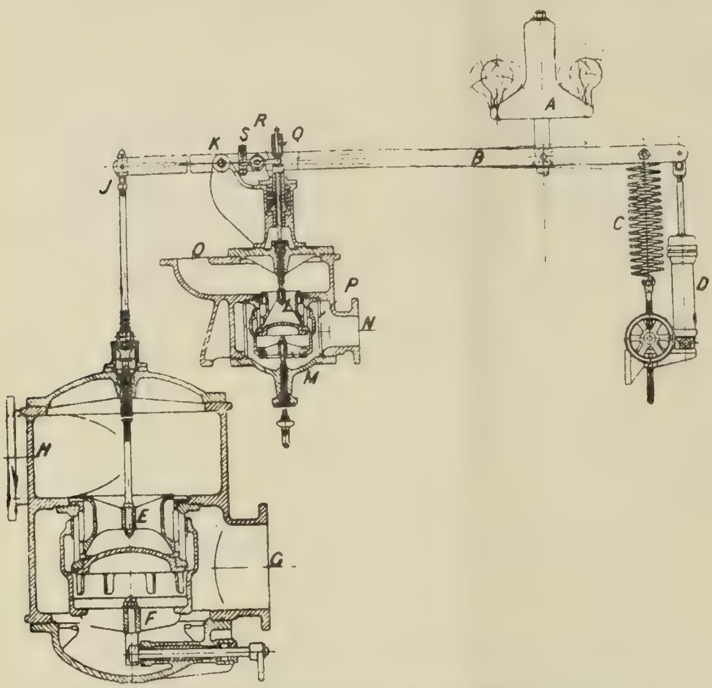


FIG. 74.—GOVERNOR GEAR FOR A MIXED PRESSURE TURBINE.

pressure turbine for use with steam at boiler pressure only, although the construction of a mixed-pressure disc and drum turbine is very similar, but in this case low-pressure steam is, of course, admitted to the low-pressure blading, and the governor gear must be modified accordingly.

A Governor Gear for Mixed-Pressure Working.

The governor gear used for mixed-pressure working is shown in Fig. 74. A is the main governor; B, the main governor lever; C, the hand regulator; D, the dashpot; E, the low-pressure throttle valve; F, the low-pressure emergency valve; G, the low-pressure steam inlet; H, the low-pressure passage leading to the turbine; J, an adjusting screw for the low-pressure valve; K, the fulcrum for the main lever; L, the high-pressure throttle valve; M, the high-pressure emergency valve; N, the high-pressure steam inlet; O, the high-pressure steam passage leading to the turbine: P, the high-pressure steam strainer; Q, the adjusting screw for the high-pressure valve: R, the rocking lever controlling the opening of the high-pressure valve; and S, the adjusting screw for the high-pressure valve. The operation of the gear is very simple. The main governor lever B rocks on the fulcrum K, and operates the low-pressure valve E directly. The high-pressure valve, it will be noticed, is placed between the governor and the fulcrum, and the small rocking lever R is adjusted so that both valves close in the same direction. This small lever also allows the necessary adjustment to be made to meet any desired conditions, this adjustment being altered by means of the screw S, and the position of this screw determines the point at which high-pressure steam is admitted to the turbine. The governor always gives preference to low-pressure steam when it is available, but high-pressure steam is admitted to the machine when the low-pressure supply is insufficient to deal with the load.

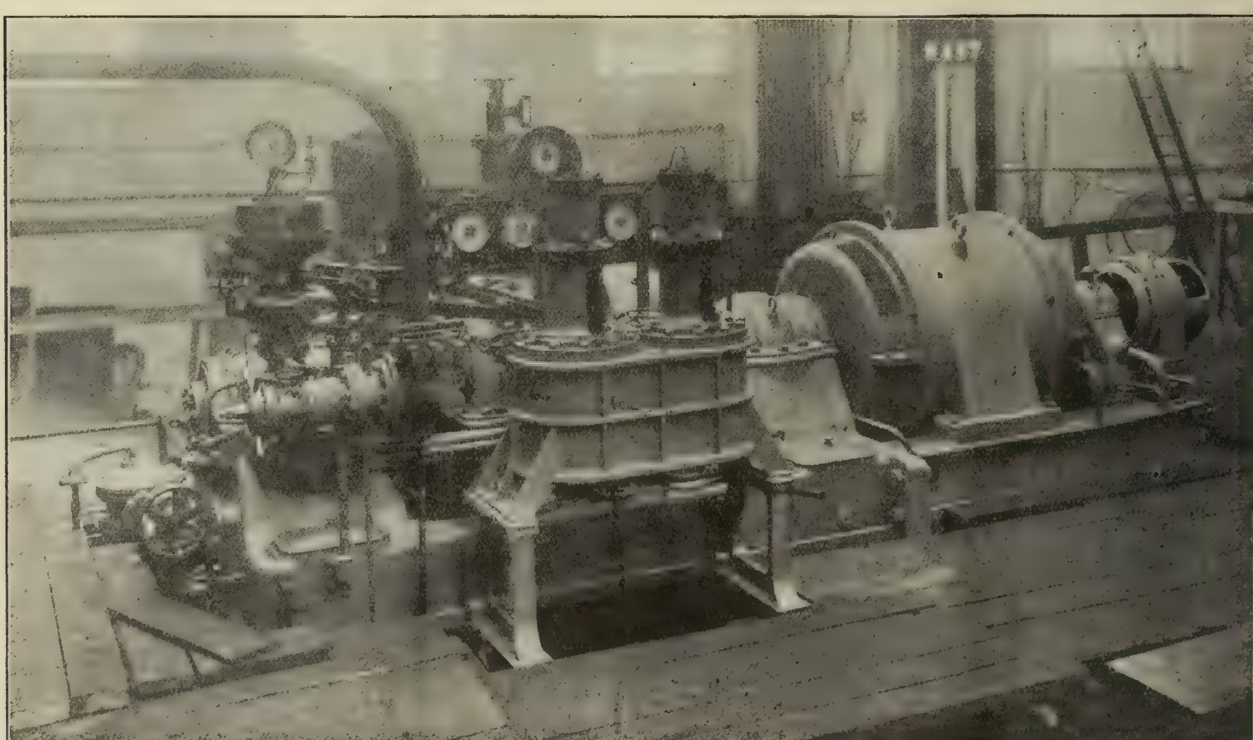


FIG. 75. A 500 KILOWATT MIXED PRESSURE TURBINE

Weights of Lengths of Rolled Steel Sections.

Beam 5 in. × $4\frac{3}{16}$ in. × 19 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	Ft.
0	..	1 2 22	3 1 16	5 0 10	6 3 4	8 1 26	10 0 20	11 3 14	13 2 8	0 15 1 2	0
1	0 0 19	1 3 13	3 2 7	5 1 1	6 3 23	8 2 17	10 1 11	12 0 5	13 2 27	0 15 1 21	1
2	0 1 10	2 0 4	3 2 26	5 1 20	7 0 14	8 3 8	10 2 2	12 0 24	13 3 18	0 15 2 12	2
3	0 2 1	2 0 23	3 3 17	5 2 11	7 1 5	8 3 27	10 2 21	12 1 15	14 0 9	0 15 3 3	3
4	0 2 20	2 1 14	4 0 8	5 3 2	7 1 24	9 0 18	10 3 12	12 2 6	14 1 0	0 15 3 22	4
5	0 3 11	2 2 5	4 0 27	5 3 21	7 2 15	9 1 9	11 0 3	12 2 25	14 1 19	0 16 0 13	5
6	1 0 2	2 2 24	4 1 18	6 0 12	7 3 6	9 2 0	11 0 22	12 3 16	14 2 10	0 16 1 4	6
7	1 0 21	2 3 15	4 2 9	6 1 3	7 3 25	9 2 19	11 1 13	13 0 7	14 3 1	0 16 1 23	7
8	1 1 12	3 0 6	4 3 0	6 1 22	8 0 16	9 3 10	11 2 4	13 0 26	14 3 20	0 16 2 14	8
9	1 2 3	3 0 25	4 3 19	6 2 13	8 1 7	10 0 1	11 2 23	13 1 17	15 0 11	0 16 3 5	9

Weight of Beam, advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight.	lbs. 1·58	lbs. 3·16	lbs. 4·76	lbs. 6·33	lbs. 7·92	lbs. 9·50	lbs. 11·08	lbs. 12·67	lbs. 14·25	lbs. 15·84	lbs. 17·42	lbs. 19	Weight.

Weights of Lengths of Rolled Steel Sections.

Beam 5 in. × $4\frac{3}{16}$ in. × 19 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	0 16 3 24	1 13 3 20	2 10 3 16	3 7 3 12	4 4 3 8	5 1 3 4	5 18 3 0	6 15 2 24	7 12 2 20	0
10	0 1 2 22	0 18 2 18	1 15 2 14	2 12 2 10	3 9 2 6	4 6 2 2	5 3 1 26	6 0 1 22	6 17 1 18	7 14 1 14	10
20	0 3 1 16	1 0 1 12	1 17 1 8	2 14 1 4	3 11 1 0	4 8 0 24	5 5 0 20	6 2 0 16	6 19 0 12	7 16 0 8	20
30	0 5 0 10	1 2 0 6	1 19 0 2	2 15 3 26	3 12 3 22	4 9 3 18	5 6 3 14	6 3 3 10	7 0 3 6	7 17 3 2	30
40	0 6 3 4	1 3 3 0	2 0 2 24	2 17 2 20	3 14 2 16	4 11 2 12	5 8 2 8	6 5 2 4	7 2 2 0	7 19 1 24	40
50	0 8 1 26	1 5 1 22	2 2 1 18	2 19 1 14	3 16 1 10	4 13 1 6	5 10 1 2	6 7 0 26	7 4 0 22	8 1 0 18	50
60	0 10 0 20	1 7 0 16	2 4 0 12	3 1 0 8	3 18 0 4	4 15 0 0	5 11 3 24	6 8 3 20	7 5 3 16	8 2 3 12	60
70	0 11 3 14	1 8 3 10	2 5 3 6	3 2 3 2	3 19 2 26	4 16 2 22	5 13 2 18	6 10 2 14	7 7 2 10	8 4 2 6	70
80	0 13 2 8	1 10 2 4	2 7 2 0	3 4 1 24	4 1 1 20	4 18 1 16	5 15 1 12	6 12 1 8	7 9 1 4	8 6 1 0	80
90	0 15 1 2	1 12 0 26	2 9 0 22	3 6 0 18	4 3 0 14	5 0 0 10	5 17 0 6	6 14 0 2	7 10 3 26	8 7 3 22	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lb. 8 9 2 16	t. c. q. lb. 16 19 1 4	t. c. q. lb. 25 8 3 20	t. c. q. lb. 33 18 2 8	t. c. q. lb. 42 8 0 24	t. c. q. lb. 50 17 3 12	t. c. q. lb. 59 7 2 0	t. c. q. lb. 67 17 0 16	t. c. q. lb. 76 6 3 4	t c. q. lb. 84 16 1 20	Weight

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Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 7 in. × 7 in. × 31·5 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 3 7	5 2 10	8 1 21	11 1 0	14 0 7	16 3 14	19 2 21	1 2 2 0	1 5 1 7	0
1	0 1 3·5	3 0 10·5	5 3 17·5	8 2 24·5	11 2 3·5	14 1 10·5	17 0 17·5	19 3 24·5	1 2 3 3·5	1 5 2 10·5	1
2	0 2 7	3 1 14	5 0 21	8 0 0	11 3 7	14 2 14	17 1 21	1 0 1 0	1 3 0 7	1 5 3 14	2
3	0 3 10·5	3 2 17·5	6 1 24·5	9 1 3·5	12 0 10·5	14 3 17·5	17 2 24·5	1 0 2 3·5	1 3 1 10·5	1 6 0 17·5	3
4	1 0 14	3 3 21	6 3 0	9 2 7	12 1 14	15 0 21	18 0 0	1 0 3 7	1 3 2 14	1 6 1 21	4
5	1 1 17·5	4 0 24·5	7 0 3·5	9 3 10·5	12 2 17·5	15 1 24·5	18 1 3·5	1 1 0 10·5	1 3 3 17·5	1 6 2 24·5	5
6	1 2 21	4 2 0	7 1 7·0	10 0 14	12 3 21	15 3 0	18 2 7	1 1 1 14	1 4 0 21	1 7 0 0	6
7	1 3 24·5	4 3 3·5	7 2 10·5	10 1 17·5	13 0 24·5	16 0 35	18 3 10·5	1 1 2 17·5	1 4 1 24·5	1 7 1 3·5	7
8	2 1 0	5 0 7·0	7 3 14·0	10 2 21	13 2 0	16 1 7	19 0 14	1 1 3 21	1 4 3 0	1 7 2 7	8
9	2 2 3·5	5 1 10·5	8 0 17·5	10 3 24·5	13 3 3·5	16 2 10·5	19 1 17·5	1 2 0 24·5	1 5 0 3·5	1 7 3 10·5	9

Weight of Beam, advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	Weight.
	2·625	5·25	7·875	10·5	13·125	15·75	18·375	21·0	23·625	26·25	1 0·875	1 3·5	

Weights of Lengths of Rolled Steel Sections.

Beam 7 in. × 7 in. × 31·5 lbs. per foot.

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Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	1 8 0 14	2 16 1 0	4 4 1 14	5 12 2 0	7 0 2 14	8 8 3 0	9 16 3 14	11 5 0 0	12 13 0 14	0
10	0 2 3 7	1 10 3 21	2 19 0 7	4 7 0 21	5 15 1 7	7 3 1 21	8 11 2 7	9 19 2 21	11 7 3 7	12 15 3 21	10
20	0 5 2 14	1 13 3 0	3 1 3 14	4 10 0 0	5 18 0 14	7 6 1 0	8 14 1 14	10 2 2 0	11 10 2 14	12 18 3 0	20
30	0 8 1 21	1 16 2 7	3 4 2 21	4 12 3 7	6 0 3 21	7 9 0 7	8 17 0 21	10 5 1 7	11 13 1 21	13 1 2 7	30
40	0 11 1 0	1 19 1 14	3 7 2 0	4 15 2 14	6 3 3 0	7 11 3 14	9 0 0 0	10 8 0 14	11 16 1 0	13 4 1 14	40
50	0 14 0 7	2 2 0 21	3 10 1 7	4 18 1 21	6 6 2 7	7 14 2 21	9 2 3 7	10 10 3 21	11 19 0 7	13 7 0 21	50
60	0 16 3 14	2 5 0 0	3 13 0 14	5 1 1 0	6 9 1 14	7 17 2 0	9 5 2 14	10 13 3 0	12 1 3 14	13 10 0 0	60
70	0 19 2 21	2 7 3 7	3 15 3 21	5 4 0 7	6 12 0 21	8 0 1 7	9 8 1 21	10 16 2 7	12 4 2 21	13 12 3 7	70
80	1 2 2 0	2 10 2 14	3 18 3 0	5 6 3 14	6 15 0 0	8 3 0 14	9 11 1 0	10 19 1 14	12 7 2 0	13 15 2 14	80
90	1 5 1 7	2 13 1 21	4 1 2 7	5 9 2 21	6 17 3 7	8 5 3 21	9 14 0 7	11 2 0 21	12 10 1 7	13 18 1 21	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight
	14 1 1 0	28 2 2 0	42 3 3 0	56 5 0 0	70 6 1 0	84 7 2 0	98 8 3 0	112 10 0 0	126 11 1 0	140 12 2 0	

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Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

The Brush Disc and Drum Turbine.

Another firm building disc and drum mixed-pressure turbines is the Brush Electrical Engineering Co., of Loughborough, and an illustration of a complete 500 kilowatt set made by this firm is shown in Fig. 75, the high and low pressure valves being shown in the foreground.

(To be continued.)

CHIMNEY STACKS.

By James Claughton.

(Continued from page 94.)

The following symbolic expressions are to be considered as imaginary, and are given to express a logical line of thought from which we can ultimately build up a series of rational formulæ that are particularly applicable to chimney calculations.

Let p_1 = initial pressure of waste gases.
,, p_2 = outlet pressure of waste gases.

Therefore $p_1 - p_2$ = pressure drop $= d$.

Let f = a coefficient due to friction or eddy current action inside the chimney shaft. Then $f p_1 = p_2$, thus $d = p_1 (1 - f)$.

From the combination of Boyle's and Gay-Lussac's laws, the following expression is established for any perfect gas at any known pressure :— $\frac{pV}{T}$ = a constant, from which is derived $w = \frac{p\,V}{R\,T}$.

Where V = volume.
,, w = weight of gas.
,, p = pressure.
,, R = a constant for any particular gas.
,, T = absolute temperature.

Thus $p_1 = \frac{w\,R\,T}{V}$, which considering unit volume only, becomes equal to $p_1 = w\,R\,T$. Substituting this value for p_1 in the foregoing expression for d, we get :— $w\,R\,T\ (1 - f) = d$ = pressure drop.

An elementary law of mechanics states that for all matter having density $v^2 = 2\,g\,h$, where $g = 32{\cdot}2$ the acceleration due to gravity, and h = the height through which the body falls. This law has been found to be applicable to other than falling bodies, and this particularly applies to both liquids and gases under pressure.

Let $p = w\,h$, for gases, $\therefore$ hence $h = \frac{p}{w}$, and substituting this value for h, we obtain the fundamental equation for the velocity of gases : $v = \sqrt{\frac{2\,g\,p}{w}}$.

Let v = velocity at pressure p_1.
,, v_1 = velocity at pressure p_2.
,, v_c = velocity coefficient of friction.

$v = \sqrt{\frac{2\,g\,p_1}{w_1}}$, and $v_1 = \sqrt{\frac{2\,g\,p_2}{w_2}}$, but $p_2 = f\,p_1$ and if w be the average of w_1 and w_2, we get :—$v_1 = \sqrt{\frac{2\,g\,f\,p_1}{w}}$.

Loss of velocity due to friction $= v - v_1$, thus let the loss of velocity equal the velocity coefficient of friction v_c.

Hence $(v^2 - v_1^2) = v_c^2$, or $\left(\frac{2\,g\,p_1}{w} - \frac{2\,g\,f\,p_1}{w}\right) = v_c^2$.

Whence $f = v_c^2$.

From the foregoing reasoning, we can state that the loss of velocity due to two different pressures p_1 and p_2, equals the velocity as given by the pressure difference $(p_1 - p_2)$.

Thus $v_c = \sqrt{\frac{2\,g\,d}{w}}$, and transposing ; $d = \frac{w\,v_c^2}{2\,g}$. (I.)

To study this subject carefully the following relations are most useful :—From the fact that pressure bears a definite relation to velocity, we can show that—

$$p_1 = \frac{w\,v^2}{2\,g} \text{ and } p_2 = \frac{w\,v_1^2}{2\,g},$$

but $f\,p_1 = p_2$, and $f = v_c^2$, hence $p_1\,v_c^2 = p_2$.

Thus
$$p_1 = \frac{w\,v_1^2}{2\,g\,v_c^2},$$

and
$$d = \left(\frac{w\,v_1^2}{2\,g\,v_c^2} - \frac{w\,v_1^2}{2\,g}\right) = \frac{w\,v_1^2}{2\,g}\left(\frac{1}{v_c^2} - 1\right). \qquad \text{(II.)}$$

Let $d = F\,p_1 = \frac{F\,w\,v_1^2}{2\,g\,v_c^2}$, if this expression be equated to formula II., thus :—

$\frac{F\,w\,v_1^2}{2\,g\,v_c^2} = \frac{w\,v_1^2}{2\,g}\left(\frac{1}{v_c^2} - 1\right)$, and solving for F, we have

$$F = 1 - v_c^2. \qquad \text{(III.)}$$

If F_2 be the multiplier when considering the final pressure p_2, we have $d = F_2\,p_2$, hence $F\,p_1 = F_2\,p_2$, but $F = 1 - v_c^2$.

Thus :— $\frac{(1 - v_c^2)\,w\,v_1^2}{2\,g\,v_c^2} = \frac{F_2\,w\,v_1^2}{2\,g}$, and solving for F_2, we have $F_2 = \left(\frac{1}{v_c^2} - 1\right)$. (IV.)

Referring to formula II. it will be observed that

$$d = \frac{F_2\,w\,v_1^2}{2\,g}. \qquad \text{(II.)}$$

The foregoing have been considered in the light of symbolic expressions only, but from the reasoning there stated, we can deduct the statement that loss of pressure due to friction equals the pressure equivalent of velocity multiplied by some determinable value due entirely to the frictional resistance of the scrubbing action of the gases on the chimney sides

The actual value of the frictional element will depend entirely on the local conditions governing at the site.

With gases we can, therefore, state the following laws by which the relation of the loss of pressure or *pressure drop* to friction can be definitely determined for any known case.

Firstly.—It varies directly as the area of the surface in contact with the moving gases.

Secondly.—It varies directly as the roughness of the contact surface.

Thirdly.—It varies directly as the square of the velocity.

Expressing the above laws in mathematical terms, $d = f_1\,s\,v^2$.

Where d = pressure drop $= (p_1 - p_2)$.
,, f_1 = coefficient of skin friction.
,, s = area of contact surface.
,, v = initial velocity of flow of gases

Considering any plane cross section of thr chimney shaft, it will be evident that the total pressure drop will equal the product of the difference in pressure and the cross sectional area of the chimney, or in terms d A.

Equating the foregoing expressions we get :—

$$d\,A = f_1\, s\, v^2, \qquad \text{(V.)}$$

but $\quad A = \frac{\pi}{4} D^2$, and $s = \pi\, D\, h$,

substituting these values in formula V., we get

$$\frac{\pi}{4} D^2\, d = f_1\, \pi\, D\, h\, v^2.$$

Hence :—

$$d = \frac{4 f_1\, h\, v^2}{D}. \qquad \text{(VI.)}$$

Transposing formula VI. for velocity,

$$v^2 = \frac{d\,D}{4 f_1\, h} = \frac{D}{4 f_1\, h}(p_1 - p_2). \qquad \text{(VII.)}$$

The coefficient of skin friction f_1 can be definitely expressed for any particular chimney thus :—

$$f_1 = \frac{d\,A}{s\,v^2} = \frac{p_1\,(1-f)\,A}{\pi\,D\,h\,v^2} = \frac{D\,p_1\,(1-f)}{4\,h\,v^2} \qquad \text{(VIII.)}$$

where f is the multiplier of p_1, or the relation that p_1 bears to p_2, *i.e.* :—$f\,p_1 = p_2$, from which d $= p_1\,(1-f)$.

In the symbolic expressions previously given it was shown that $v^2 = 2\,g\,h$. To apply this law to deal with gases in a practical manner it was found necessary to substitute terms of pressure for the height, thus in our particular case h will equal a column of gas the actual weight of which will correspond to the pressure drop.

Thus, $\quad d = (p_1 - p_2) = w\,h$,
where $\quad h$ = height in feet of chimney shaft,
and $\quad w$ = weight of one cubic foot of gas.

Then $\quad h = \frac{(p_1 - p_2)}{w}$

and $\quad v^2 = 2\,g\,\frac{(p_1 - p_2)}{w}. \qquad$ (IX.)

But w has been shown to equal $\frac{p\,v}{R\,T}$, substituting in formula (IX.), and the final expression becomes :—

$$v^2 = 2g\,R\,T\,\frac{(p_1 - p_2)}{p_1}. \qquad \text{(X.)}$$

Equating formulæ VII. and X. thus :—

$$\frac{D}{4 f_1\, h}(p_1 - p_2) = \frac{2\,g\,R\,T}{p_1}(p_1 - p_2)$$

and solving for f_1 we get :—

$$f_1 = \frac{D\,p_1}{8\,g\,R\,T\,h} = \frac{w\,D}{8\,g\,h}. \qquad \text{(XI.)}$$

The coefficient f_1 will vary for every chimney constructed, hence the writer will term this coefficient the *chimney factor*. The author has found this *chimney factor* very useful when comparing the performances of several chimneys from a given datum as it were.

Expressions in known terms can be derived for the coefficients f, F, F_2, and v_c stated in formulæ I., II., III., and IV., by substitution and transposition from formulæ V. to XI.

To adapt formula X. to conform with present chimney practice for use with ordinary boiler plants multiply by one-third, thus .

$$v_a = \tfrac{1}{3}\sqrt{\frac{2\,g\,R\,T}{p_1}(p_1 - p_2)}. \qquad \text{(XII.)}$$

or $v_a = 13{\cdot}4\ d^{\cdot 5}$ when w is taken equal to ·04 lbs. per cubic foot.

Let Q = quantity of waste gases in cubic feet delivered to the chimney per second. Then

$$Q = 10{\cdot}5\ D^2 d^{\cdot 5}. \qquad \text{(XIII.}$$

Taking into consideration the rapid strides recently made in the direction of the scientific control of steam boiler plants, together with the vastly improved mechanical appliances now used, which in practice means a greater efficiency, it follows that the time is drawing near when a velocity of about 50 feet per second may be adopted. To enable the foregoing to be actually carried out in practice it means that the chimney stack must be designed on scientific lines. The result will be that a greater economy will be effected in addition to a huge saving in the first or capital cost of a new plant.

To show the feasibility of the foregoing suggestion, it can be definitely stated that the weight of a cubic foot of waste gas at atmospheric temperature is approximately twice the weight of the hot gas at the foot of the chimney shaft. For practical purposes this is quite near enough, so that if formula X. be multiplied by $\frac{1}{2}$ it would, in the writer's opinion, be more in general agreement with the theoretical requirements than present practice suggests.

Should the above suggestions be ultimately carried out, practical working values could be given for the various coefficients herein stated.

Further, the *chimney factor* ;

$$f_1 = \frac{D\,p_1}{8\,g\,R\,T\,h} = \frac{D\,p_1\,(1-f)}{4\,h\,v^2},$$

formulæ XI. and VIII. respectively, will become a practical means for comparing chimneys from a common datum; in fact, it is just possible that a fixed value may be given in terms of the draught required.

Various writers give the following as the formula for the flow of air in a long pipe :—

$$v_a = \sqrt{\frac{12\,g\,R\,T\,D}{4\,f\,h}\left(\frac{p_1^2 - p_2^2}{p_1^2}\right)}$$

which, when simplified, becomes :—

$$v_a = \frac{5{\cdot}98}{p_1}\sqrt{\frac{T\,D}{f\,h}(p_1^2 - p_2^2)}. \qquad \text{(XIV.)}$$

and for the quantity of gases delivered :—

$$Q = \frac{4{\cdot}696}{p_1}\sqrt{\frac{D\,T}{f\,h}(p_1^2 - p_2^2)}. \qquad \text{(XV.)}$$

The above are given to enable a comparison to be made, if desired, but for chimney work the author prefers to use formulæ XII. and XIII., with possible modifications to be described in the examples to follow.

(*To be continued.*)

ENGINEERING LAY-OUT ARRANGEMENTS AND TENDER DRAWINGS.

By Douglas Wilson, A.M.I.Mech.E.

(*Continued from page 114.*)

The by-pass system is generally indicated at Figs. 37 and 38. Valves and tees are numerous, as will be seen; joints also are not in the minority. As the name implies, this method enables any set to be by-passed from the main pipe line by means of the valves provided; it should come somewhat cheaper than the duplex system, but the safety factor is not

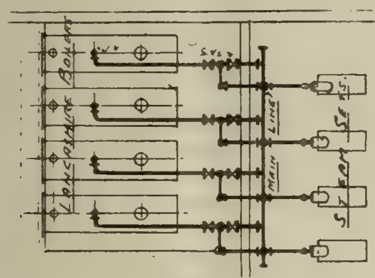
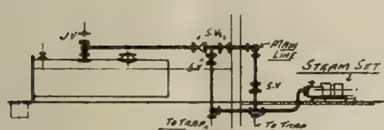


Fig. 37.



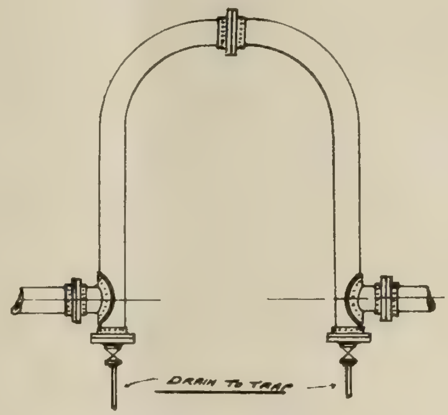
Engineering Lay-out.—Fig. 38.

so high. It still has the bad point, like the ring main, viz., the danger of joints, etc., going when a cool section is suddenly opened up. Either boiler can be used to either sets, or any boiler cut out, as desired.

The aims the draughtsman should go for in making his layout of steam mains should be:—The lines should be as short and direct as possible, and as few in number. Avoid expansion bends, if possible, by the judicious use of bends. Keep down the number of joints to the minimum; carefully go into the water drainage, and make provision for expansion and contraction.

The main pipe lines should fall in one direction for drainage. The separator should be close to the engine, and the boiler stop valve should be the highest point of the range. If the pipe lines alternately rise and fall, the lowest points should be provided with pockets and traps. As regards the diameters of the pipes in the steam range, it is of course necessary to know how much steam you require passing before settling on this, and also the pressure, and whether superheated steam is used.

The usual velocity taken for superheated steam is, say, 100 ft. to 110 ft. per second at the engine stop valve, and for saturated steam, say, 75 ft. to 90 ft., this velocity being lower on account of the water vesicles present in the steam flow. When the



Engineering Lay-out.—Fig. 40.

pressure is fixed, the size of the pipe can then readily be obtained, the simple formula being:—

$$\frac{S \times O \times 144 \times Vol}{Vel \times 60 \times 60} = \text{area of pipe in sq. ins.}$$

Where S = Steam consumption in lbs. per kilowatt or brake-horse power hour.

O = Output in kilowatts or brake-horse power of plant.

Vol = Volume of 1 lb. of steam in cubic feet at the steam pressure decided on.

Vel = Velocity of steam in feet per second. (this not to be reckoned too high if there are many bends, valves, etc., in the pipe line).

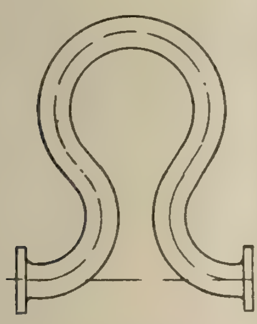
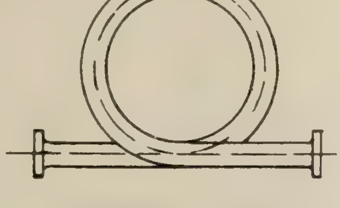


Fig. 39.



Engineering Lay-out.
Fig. 41.

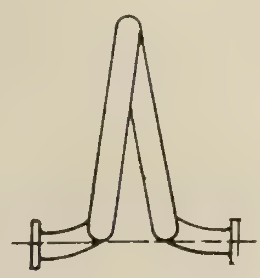


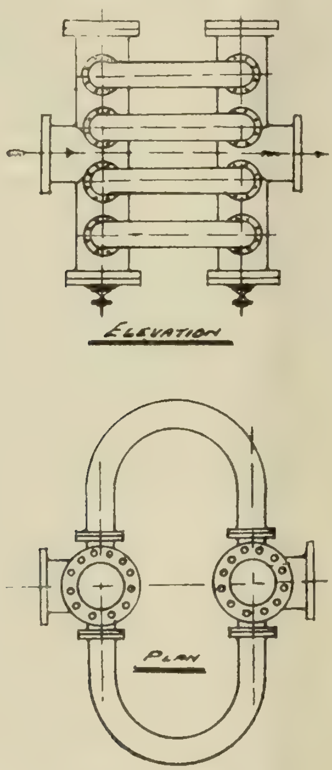
Fig. 42.

Expansion Bends and Joints

Efficient expansion bends or joints are very essential in a steam piping system, as due allowance must be made for linear expansion. A common rule is to allow 1 in. for every 50 ft. for saturated steam. With superheated steam, $1\frac{1}{2}$ in. to $1\frac{3}{4}$ in. for the same length; 0.36 in. per 10 ft. with superheated steam at 550 deg. Fah. is a safe figure. In a long range of piping the expansion piece should be placed centrally or nearly so, and the ends of the range

should be anchored. This will ensure each bend, if an expansion bend is used, receiving its own portion of work. The anchoring of the pipe lines must be in one direction only, viz., longitudinally, and this should be efficiently carried out. The building walls are generally the most convenient points which to anchor the pipes, and the wall selected for this purpose should be a good one, not les than 14 in. thick. The pipe may be clamped to a heavy sole plate firmly bolted to the wall. Columns also may be made use of for anchoring, the pipe being carried on a strong cast-iron bracket clipped to the column.

Figs. 39 and 40 are common forms of bends. The example at Fig. 39 is generally made in one piece up to 10 in. bore, and above this in two bends as shown at Fig. 40. This horseshoe type of bend is very elastic, and is generally adopted. Bends should be placed horizontally wherever practicable, and if



Engineering Lay-Out. Fig. 43.

they are placed vertically, the lower ends must be connected by elastic pipes to the trap, as shown in Fig. 40., so as to ensure all water draining away.

These bends should be sprung or forced open into place so that their movement, hot or cold, will be equal, or as near as it is possible to determine, thus exerting a pull in the pipe line when cold and a thrust when hot.

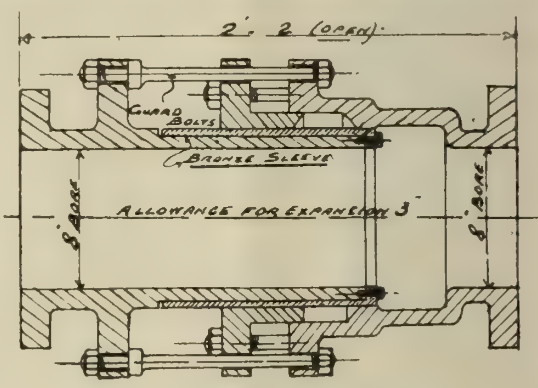
The loops shown at Figs. 41 and 42 are sometimes installed. Fig. 41 is suitable where there is a change of level slightly exceeding the diameter of the pipe. Fig. 42 is the most flexible type, the stresses being torsional.

Where no room is available for a large horseshoe bend, the type shown in Fig. 43 is sometimes substituted. Though possessing many joints, the author prefers this type to the sliding-expansion joints, as these require regular attention, and are liable to stick.

Two types of expansion joints are indicated at Figs. 44 and 45. These joints are not often used on account of their expense and constant leakage at the glands.

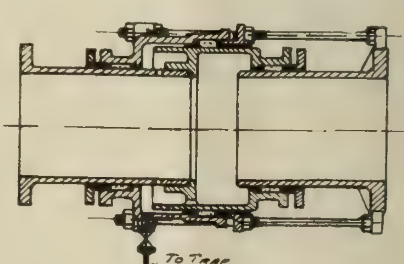
The magnitude of the thrusts calls for a very strong and firmly-fixed anchor for the type shown in Fig. 44, which is unbalanced.

The joint shown in Fig. 45 is balanced; that is, the pressures tending to separate the pipe ends are



Engineering Lay-Out Fig. 44.

balanced by the pressure in the annular ring surrounding the pipe. This balancing pressure acts directly on the left pipe end through the cylindrical piece secured to the pipe end, and is transmitted to the other pipe end through the stays by which this end is connected to the outer cylindrical piece. It will thus be seen that the friction in the stuffing boxes is the only resistance to be overcome when the pipe expands. A total movement of 4 in. is generally allowed for on these joints. Expansion joints of these last two types are only recommended where the pipe line is of considerable length, and conditions are such that the employment of bends is



Engineering Lay-Out.—Fig. 45.

not feasible. Swivel expansion joints are sometimes used. These provide a universal movement in bending. They are not, strictly speaking, expansion joints, and are generally fixed, say, in the branch pipes of the boiler, allowing for a free movement of the main pipe without straining the branch pipes.

Provision should always be made on or near expansion joints for a water drain cock, as shown on the balanced joint, Fig. 45.

(To be continued.)

DRAWING OFFICE SYSTEMS AND MANAGEMENT.

By M. Coronel.

(*Continued from page 64.*)

Chests for Filing Drawings.

All drawings should be filed away every night before closing-time in specially-constructed chests holding a number of drawers. These chests should be made to the following sizes to hold the different sizes of sheets. Drawers for A sheets only: Inside sizes of drawer, 42 in. wide by 28 in. deep by $2\frac{1}{4}$ in. high, each chest to contain 10 drawers; total height of chests, 3 ft. 6 in., and drawers to be 6 in. from floor (see Fig. 8), so as to be able to sweep underneath and the tops of the chests to be used for laying-off tables prior to the filing away of the draw-

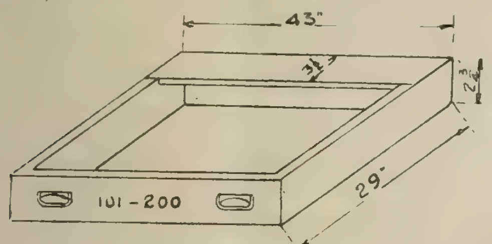


FIG 6. FILING DRAWER FOR A SHEETS

ings. Each drawer to contain not more 100 to 150 drawings, as if more are put in they are inaccessible. The drawers should have a wide board on the top at the back to prevent drawings slipping over the edge (see Fig. 6).

Ordering Material.

There are two ways of ordering material commonly used in the shops. This is either done on the drawing, and is part and parcel of the bill of material (see Fig. 10), or can be ordered on the drawing in a separate order column (see Fig. 11). It may also be done on separate shop order sheets, the drawing in this case simply giving the item numbers and

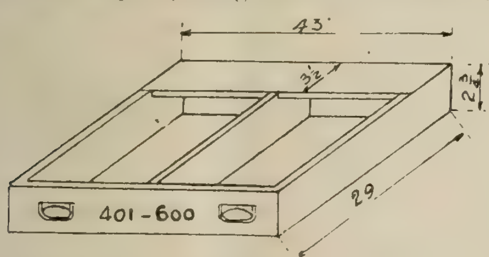


FIG. 7. FILING DRAWER FOR B SHEETS

material. In the case of the former method, it saves a good deal of paper and clerical work writing up these sheets for the various shops, but it has the disadvantage that, in standard drawings, which are often used for different jobs, the addition of a new order has to be made to the drawings in the shops, which entails their being recalled, changed, and returned. This wastes a good deal of valuable time and consequent costs.

In the latter case, all that is necessary is to issue for each order a new set of separate specification or order sheets, which should have, with advantage, a different colour for every shop. This is usually according to the material handled in that shop, as, for instance, yellow for the brass foundry, slate for the iron foundry, blue for the smithy, violet for the steel foundry, etc., and the original of the drawing office on white paper. These specification sheets (see Fig. 12) give full particulars

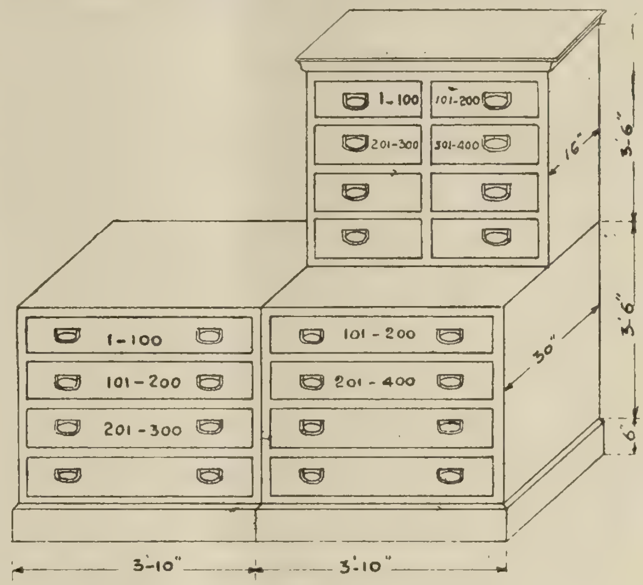
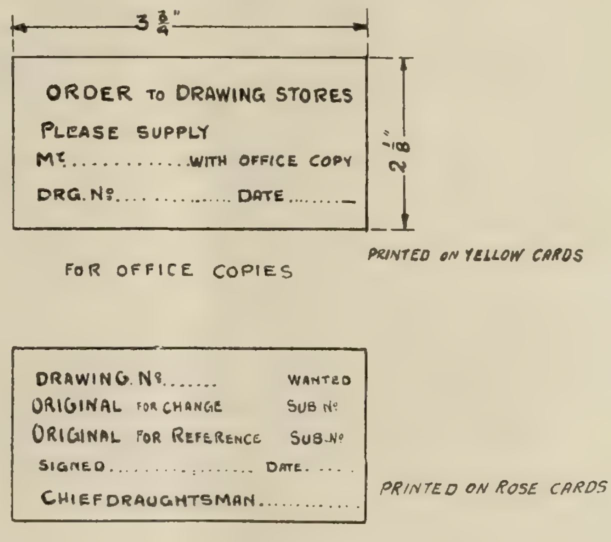


FIG. 8. DRAWINGS FILING CHESTS.

TOP FOR C & D SHEETS. BOTTOM FOR A & B SHEETS

of the order number, customer, number off required, material, part number on drawing, and the description of the part handled in that particular shop only.

When the ordering is, however, done on the drawing, the method adopted varies with the class of drawing, as a drawing is always used in its entirety,



FOR ORIGINAL DRGS.

Fig. 9.

viz., exactly as to quantities and material as ordered on the original drawing. It is a simpler method to make the order column separate from the material list, and simply order in this order list " one set off for Order No. ...., etc. (see Fig. 11). If the

drawing is repeatedly used, but not every item or the numbers of items are not always the same, and also where there is a change in the material, it is advisable to combine the order column with the material list, and reserve a column for every order, every subsequent order being written up in front of its predecessor (see Fig. 10). Oil pipe drawings,

MATERIAL LIST FOR ORDERS

S.O 195 Nº OFF	S.O 172 Nº OFF	MAT.	PATT Nº	DESCRIPTION	REF.	PATT. OR STOCK Nº
1	2	C.I.	1	CYLINDER		P2030.
1	2	C.I.	2	COVER		P.2020
2	4	BR.	3	GLAND BUSH	STICK	S.1510
12	24	M.S.	4	STUDS 7/8" DIA. 6" LONG, SR° 1¾" & 1¼"	STOCK	1432

FIG. 10.

and those with many fittings, lend themselves to the latter method, whereas engine pistons complete are better ordered according to the former.

B Sheets.

A separate chest of drawers to hold B sheets only and to be the same size in all respects as the A size chests and drawers, except that each drawer has a division half its width from front to back (see Fig. 7).

C Sheets.

A separate chest of drawers to hold C sheets, only the drawers to be 22 in. wide inside by 15 in. deep and 2¼ in. high. Twenty drawers in a chest in pairs side by side, the chests to be again 6 in. from the floor and 3 ft. 6 in. high, and same width as these for A sheets, but about half the depth. Or if pre-

MATERIAL LIST FOR ONE ENGINE

ITEM Nº	MAT.	Nº OFF	DESCRIPTION	REF	PATT OR STOCK Nº
1	C.I.	1	CYLINDER		P2030
2	C.I.	1	COVER		P2020
3	BR.	2	GLAND BUSH	STICK	S1510
4	M.S.	12	STUDS 7/8 x 5¼ LONG, SR° 1¾ & 1¼	STOCK	1432

ORDER LIST

ORDER Nº	Nº OF SETS REQUIRED	REMARKS
S.O. 195	1 SET AS ABOVE	
S.O. 172	2 SETS AS ABOVE	
G.O. 15	4 SETS	WITHOUT ITEM 4.

FIG. 11.

ferred, and short of room, these can be put on top of A and B chests (see Fig. 8), and the 6 in. space from the floor should then be omitted.

D Sheets.

These should be stored in similar drawers and chests as C sheets, but with a division from front to back, at half-way the width of each drawer, all drawers to have boards at back on top to prevent drawings slipping out over the edge.

Each chest contains 1,000 to 1,500 drawings, and the numbers from — to — contained in these drawers should be printed on the outside in large black letters.

A sheets are used for general arrangements and details of large castings and other parts of a machine. It is not advisable to put too many parts on one drawing, as it delays work in the shops. The whole machine should, however, be dissected into various self-contained parts, as bedplate, cylinder, casing, shaft, etc. All bolts and nuts, studs, and screws should be called for on the drawing of the parts into which they screw. All bolts and nuts, studs and nuts, screws, tap bolts, etc., should be standardised as far as possible, and a stock kept in

TO PATTERN SHOP — SHEET Nº 1

MANUFACTURING INFORMATION ON ENGINE Nº 376.

DATE 19. III. 18 — SIZE 20"+20"x40"

NAME OF DRG. BED PLATE — DRG. Nº A 4612.

NAME OF PART	ITEM Nº	Nº OFF	MAT.	PATT. Nº
BED PLATE	1	1	C.I.	P2020
HAND HOLE COVER	3	2	C.I.	P.2021
BEARING CAP	4	2	C.I.	P.2022
BEARING (TOP HALF)	6	2	G.M.	P.3011
BEARING (BOTTOM HALF)	7	2	G.M.	P.3012
OIL WELL COVER	11	1	C.I.	P.2023
BUSH	12	4	Br.	S.2001

S.O. Nº B 3765 — for CHIEF DRAUGHTSMAN

DATE 19. III. 18. — pp M. Jefferson.

FIG. 12.

the stores of the sizes most commonly used. All other articles not standardised should be drawn out, and, if repeatedly used on various drawings, should be included in the standard list, which should be made to the size called D for convenience, and left off future drawings.

Filing of Drawings.

All drawings or original tracings should be kept in a fireproof vault under the supervision of a filing clerk, who is made responsible for the proper filing away of all drawings and keeping a record of where drawings are, which are in use. For that purpose the drawings are filed away to sizes and numbers in cabinets described above.

Alterations to Drawings.

When a drawing in original tracing is wanted for alteration for re-issue, a small card coloured pink

should be handed over the counter of the stores in exchange for the drawing required. No one but the attendant should be allowed access to the stores.

Blue Prints.

For ordinary reference and every-day use, it is advisable to have a set of duplicate blue prints made of all, or at least of more frequently used drawings, and a different coloured ticket, say, blue, should be handed in to the attendant for these (see Fig. 9), and should always be used in preference to cloth tracings, so as to save the wear and tear and prolong their life.

The stores should be locked every night, so as to provide a fireproof chamber, and prevent the distruction of one of the most valuable sets of documents of an engineering works.

(*To be continued.*)

SOME OBSCURE CAUSES OF GAS ENGINE BREAKDOWN.

By F. R. PARSONS.

BOTH visual and aural signs of impending trouble with gas engines not infrequently furnish but indifferent and often quite unreliable evidence as to where one should look for causes. Fortunate indeed is he who can in a moment, and from exterior signs only—or shall we say deduction?—diagnose a specific trouble, and point a cure, for an expert not only in name, but in reality is he.

I will quote an example to put this statement beyond dispute.

Trouble with Big-end Brasses.

The present writer had been having considerable trouble, spread over a fairly long period, with an 80 B.H.P. gas engine of reputable make; the source of complaint being with the big-end brasses. The original pair sent out with the engine, a matter of 14 years ago, had, it was alleged, through former neglect and a defective lubricating system, been terribly abused, the climax being reached with an extraordinarily bad case of seizing which had involved the fitting of a new pair of brasses.

These had been cast at a local brass foundry, and despite the most careful machining and fitting, had from their inception given nothing but trouble. This had manifested itself in a variety of ways. First, they could not be kept cool; then, despite a slackening out until a perceptible knock was apparent, a cutting action of the metal ensued which tended to choke the oil grooves and channels, thus rendering lubrication difficult and ineffective. Various grades of oil were tried, the feed accelerated until both crank and brasses exuded a steam at every revolution. Finally, the crank began to exhibit signs of wear, and a micrometer showed it nearly .003 in. out of round.

Cause of Trouble.

Just when the trouble seemed unsolvable, and everyone's patience sorely taxed, there came to the shop on other matters a gas engine expert. The writer expressed a desire that before this individual left he should be asked his opinion as to the cause of the trouble. At his request the big end was disconnected, and an examination made of both brasses and crank. This was done thoroughly, and under the expert's close supervision the brasses were tried to the crank, then re-assembled and the engine started up.

Unbalanced Flywheel.

The latter had not been running three minutes when the expert turned to the writer and ventured an opinion that the reason for the trouble would be found in the flywheel. "Test it for balance," he advised, "And I shall be very much surprised if you don't find both that and the crank quite an appreciable amount out."

A little while later this was done, and the result was that a twenty-seven pound casting was eventually made and secured to the underside of the flywheel rim. This proved to be the end of our trouble in so far as the big end was concerned, and since that date, now nearly four years ago, not a single stoppage due to this cause has occurred.

Trouble After Repairs.

A further instance of an obscure cause being responsible for a deal of trouble of the provoking order should be both interesting and instructive.

A well-known make of gas engine, but of old type, was down for considerable repairs, included with which was the boring of the liner, making and fitting a new piston, and replacing tube ignition with electric low-tension magneto and a make-and-break contact device.

Bad Starting of Engine.

The latter was of that type wherein a cam attached to the end of the lay shaft operates both the magneto armature and a tappet rod carried diagonally across the cylinder end to the box-shaped casting containing the make-and-break mechanism. The latter, instead of being of sufficient length to be carried well into the combustion end, was comparatively short, communication between the ignition block and the cylinder end being established by means of a 1 in. diameter hole drilled therein.

The repairs completed, and the new attachments fitted, some difficulty was at first experienced in getting the engine off, but eventually it was persuaded to go for about 10 minutes; then, without apparent cause, it pulled up.

Without wearying the reader with a recital of the many fruitless attempts to maintain even a reasonable continuity of running conditions, or yet to enumerate the many and varied remedies adopted, it may suffice to say that the engine could not be put into work, and, in the writer's opinion, the fault lay in the ignition device. But as against this everything seemed quite in order. The magneto was separately tested, as also the contact device, yet ignition would fail for perhaps a dozen times out of 20 cycles.

Faulty Ignition.

After a spell of furious thinking, the writer felt persuaded that everything pointed to the trouble being due to some of the waste products of combustion accumulating in the pocket formed by the narrow passage between the cylinder and the ignition block, and also in the cavity of the latter.

The Remedy.

In order to put his theory to the test, he made a small fitting comprising a gun-metal threaded body with hexagonal head, and a back-pressure valve

about $^{3}/_{16}$ in. in diameter, this having a light spring attached to retain the valve on its seating, the whole being screwed into the outside top of the ignition box.

Its action was as follows:—On the charging stroke of the piston the small valve in the fitting would, against the pressure of the spiral spring attached, be opened, thus allowing ingress for a small amount of clear air to pass through the valve into the ignition block, through the orifice in the cylinder wall, thence into the cylinder; thus drawing out the foul products of combustion imprisoned therein from the previous charge, and so permitting the rich mixture of gas and air to reach the point of ignition. Upon the compression stroke the valve would, of course, be closed.

The adoption of this little device, which is quite automatic and requires no attention, enabled the word "finis" to be written against another instance wherein an obscure cause was reponsible for a deal of trouble of a perplexing character.

Engine Missing Fire.

A 26 B.H.P. "National" engine suddenly developed an unaccountable disposition to miss fire and pull up. The usual remedial measures were adopted, the ignition block overhauled, points cleared and spindles tested for a "short," as also the magneto itself; but quite unexplainably the stoppage would occur at singularly irregular intervals, now in the morning, now in the afternoon, sometimes once a day, sometimes twice, or maybe more. Thus it went on for nearly a fortnight. We possessed quite a decent gas engine fitter, one engaged direct from a large gas engine makers, but he, too, had to acknowledge himeself beaten.

Then the usual attendant fell sick and was absent for three weeks; but what made it a singular coincidence was that not once during his deputy's term of office did the engine pull up during working hours. The second day after his return, however, it again resumed its evil ways, and for another week the same unaccountable happenings went on.

Then all mechanical means failing, the present writer decided to adopt the role of a Sherlock Holmes, and essayed the solution of the mystery by laws of deduction. What, however, did eventually solve the problem was an accident.

Cause of the Trouble.

The engine attendant was a methodical old fellow, and at every mealtime was in the habit of going over the movements with a handful of waste, replacing it when finished invariably in one place, this being between the short tube, through which passes the connecting wire from the magneto to the plug, and the magneto bracket. Frequently this waste would work loose, its weight coming occasionally on one end of the wire, thus depressing it to the bottom of the tube. And where the wire just came through the tube at one end it was bared!

Need one add anything further to this explanation?

In France, as in other countries, the electro-chemical industry is being rapidly developed. The production of chlorates and sodium and their derivatives by means of electric current generated by water-power was established before the war; but great extensions are now called for. The Société d'Electro-Chimie is increasing its capital from 10¾ million francs to 15 millions, with a view to meeting the industrial requirements of the coming peace-time.

Publications.

Industrial canteen equipment has made rapid strides during the past few years, and this practical and popular "welfare work" is well recognised as being most beneficial both to employer and employee. **Messrs. The Richmond Gas Stove and Meter Co. Ltd.,** of 132 Queen Victoria Street, London, S.W., have issued a folder illustrating a few of their Industrial Canteen Installations, erected by them in various parts of the country. The firm supply and fix complete, cooking, water-boiling, and food-warming apparatus of every description suitable for catering for large or small numbers of workpeople. Gas radiators, either with or without outlet flue, are supplied for heating large buildings and workshops, being fitted with a thermostatically-operated gas valve, cutting down the supply as soon as the desired temperature is reached. A table is shown giving the approximate heating capacities of these radiators. The firm's folder concerning soldering, brazing, welding, and tool hardening by gas, illustrates several types of heaters, blowpipes, Bunsen-burners and furnaces. Special attention is called to a soldering-iron heater, having an attachment fitted by which the action of the iron being removed cuts the gas down to a pilot light. A very useful brazing table is also described, having two adjustable gas and air-blast blowpipes.

Messrs. Edward Bennis Ltd., Little Hulton, Bolton, of mechanical-stoker fame, have published a little brochure concerning the rapid discharge of railway trucks. Modern industrial processes involve the use of coal in extremely large quantities, and there is still ample room for the introduction of modern machinery for effecting economies and increasing efficiency in this respect. Briefly, a description of the operation of the apparatus is as follows: Railway lines are brought to a convenient position, under which is constructed a coal bunker of suitable size. Immediately over the top of this bunker is mounted a "Bennis" Rotary Side-truck Tippler, which enables the truck to be completely turned over to be emptied, the wagon being secured to the tippler by means of clamps, which hold it securely in position during the operation. A motor of about 5 H.P. is sufficient for this mechanism, and the coal is taken away from the receiving hopper by means of a conveyer. The operation is certainly unique; the wagon, by making a complete revolution, not only saves trimming, but also is completely emptied. Another interesting point is that the rings that hold the truck are so proportioned that their centres nearly coincide with the centre of the truck in end elevation, which makes the turning movement of the operation wonderfully even, not much counter-balancing being required. The difference between the centre of gravity of the truck loaded and empty is ingeniously provided for by means of balance weights self-contained in the tippler. Each unit is capable of dealing with 100 tons per hour, and it is perhaps desirable to say that although the installation described is for use in connection with coal, it is also capable of dealing with other materials. Another type of truck discharge plant is illustrated, in which the "Tippler" is designed to empty standard railway trucks by allowing the coal to fall by gravity through the end door of the wagon. It consists of a ram, on one end of which a crutch is fixed engaging with the rear axle. The ram is operated by a screw thread, a similar thread being turned in a phosphor-bronze wormwheel, both wormwheel and worm being contained in an oil-bath oscillating on trunnion bearings. The mechanism is worked either by a 5 H.P. motor (about), or driven by belt from adjacent shafting if so desired. The firm also specialise in complete coal and ash-handling plants, forced and induced draught apparatus, mechanical stokers, etc., many of which are in operation in this and other countries, and we feel confident that the benefit of their wide experience will be cordially extended to those having boiler-house problems.

The Parsons Marine Steam Turbine Company, Wallsend-on-Tyne, manufactured during the past four years 664,800 I.H.P. of turbine machinery—an average of 166,200 I.H.P. per annum—supplied mechanical gearing for 1,270,600 I.H.P., and cut for their licensees gearing to be used in association with turbines of 1,560,000 I.H.P.

According to a Report recently issued by the Government, the exports of tungsten ore from the Federated Malay States for the year 1917 amounted to 761.31 tons, as against 515.47 tons in 1916. In 1913 the production of tungsten ore in these States was 225.06 tons, so that the output has more than trebled since the outbreak of war.

Patent Applications.

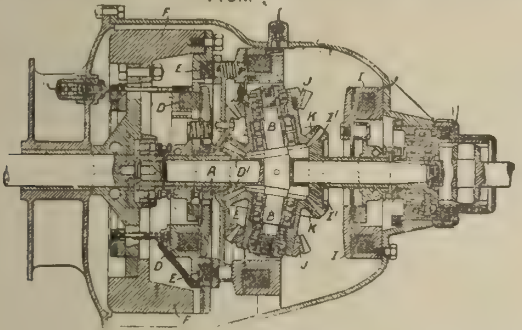
The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

ABSTRACTS OF SPECIFICATIONS.

VARIABLE-SPEED EPICYCLIC GEARING.

118,308.—G. POLLARD, 8, Clarges Street, Piccadilly, Westminster, and MENCO-ELMA SYNDICATE, Basildon House, Moorgate Street, London.—July 17th, 1917.—In epicyclic variable-speed gearing with tilted planet-wheels of the kind described in Specification 110,020, one of the two bevel sun-wheels on the braking side of the gear, together with the corresponding brake, is omitted. The driven shaft A carries inclined arms B on which turn the connected

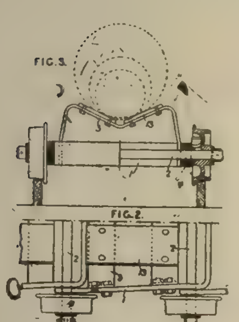
FIG. 1.



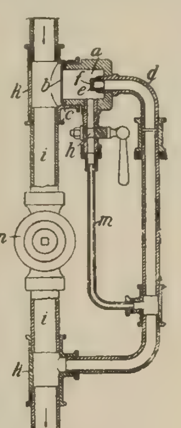
planets J, K gearing with sun-wheels D1, E1, which may be clutched by electro-magnetic clutches D, E to the driving fly-wheel F, and also gearing with a sun-wheel I1 which may be braked by a magnetic brake I or with a similarly brakeable wheel gearing with the planet-wheel J. Two forward speeds and a reverse may be obtained by the use of the possible combinations of one clutch with one brake, and a third solid-drive forward speed is obtained by closing both clutches. The vehicle may be braked by closing both brakes.

CONVEYORS.

118,350.—A. W. BENNIS, Little Hulton, Bolton, Lancashire.—Sept. 17th, 1917.—A conveyor for heavy articles such as shells comprises a series of U-links 1 held together by bolts 2 and provided with rigid supports 3 for the articles conveyed. The supports 3 may be integral with, or riveted to, the links 1 and may be faced with balata or rubber pads 13.



Patent 118,350.



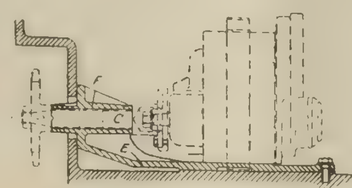
Patent 118,791.

STEAM-TRAPS.

118,791.—J. S. BRUSCHE, 3, Veelaan, Amsterdam, Holland.—Feb. 22nd, 1918.—A valveless steam-trap has suitably-arranged by-passes controlled by stop valves so that steam may be blown through to cleanse the apparatus. Water from the steam-pipe *k* is discharged through a calibrated aperture *f* in a plug *e* screwed into a branch *d* forming a by-pass across a valve *n* in the steam-pipe. The inlet to the chamber *a* enclosing the plug *e* is protected by a strainer *b*. The coarser impurities separated by the strainer fall into a pocket *i* above the valve *n*, from which they are removed and the strainer cleaned by opening the valve. The finer impurities which may have passed the strainer into the chamber *a* are discharged through a second by-pass *m* controlled by a valve *h*.

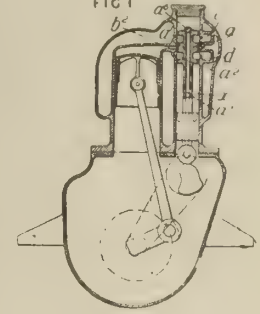
INTERNAL-COMBUSTION ENGINES.

118,801.—R. W. MAUDSLAY and STANDARD MOTOR CO., Cash's Lane, Coventry.—March 7th, 1918.—A magneto or other rotary ignition apparatus is mounted on a bed-plate E which is integral with, or bolted to, a bearing F for the driving-shaft C. Elongated holes E are provided in the plate E and bearing F so that the whole may be adjusted simultaneously.



Patent 118,801.

FIG. 1



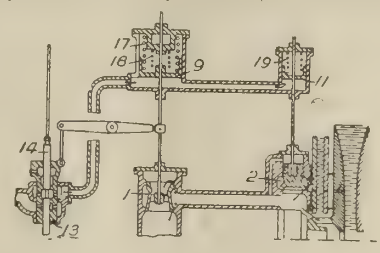
Patent 118,807.

INTERNAL-COMBUSTION ENGINES.

118,807.—A. L. F. WATTEL, 18, Avenue Henri Regnault, Sèvres, Seine et Oise, France.—March 26th, 1918.—A balanced piston valve *a* has annular inlet and outlet passages *a*1, *a*2 respectively which register with a cylinder passage *b*2 and with inlet and exhaust passages *c*, *d* in the casing *x*. The valve may be cam-actuated and may be retained in contact with the cam by a spring (not shown), or by means of an air buffer above the valve. When using an air buffer, a non-return valve *a*6 is located in a passage *a*5, through which air is delivered from the crank casing to the chamber above the valve. The valve *a*6 may be dispensed with, in which case the piston valve is cooled and lubricated by the passage of the air through the duct *a*5.

TURBINES.

118,821.—BRUSH ELECTRICAL ENGINEERING CO., 11, Arundel Street, Strand, London.—(Aktiebolaget Ljungstroms Angturbin; 2, Arsenalsgatan, Stockholm.)—May 8th, 1918.—In governing-means for turbines, comprising a primary valve 1 and an overload valve 2 operated by servo-motors 9, 11 having their fluid supply controlled by a pilot valve 14 operated by a centrifugal governor,

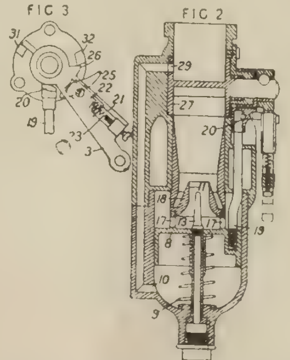


the servo-motor 9 is adapted to continue to operate the follow-up device 13 of the pilot valve after the valve 1 has been fully opened and the valve 2 has come into action. The servo-motor 9 is loaded by two springs 17, 18, the spring 18 remaining inactive until the valve 1 is fully opened, when the total pressure of the two springs corresponds to the spring load 19 on the servo-motor 11, and both servo-motors thus move uniformly when the valve 2 is in action.

INTERNAL-COMBUSTION ENGINES.

118,831.—P. GENESTIN, 23*bis*, Emile Duclaud, Suresnes, Seine, France.—Oct. 16th, 1917.—The parent Specification describes a carburettor in which the area of the passage around the nozzle is

FIG 3 FIG 2



varied by hinged flaps actuated by a spring-loaded piston subjected to the suction in the induction pipe between the throttle valve and the engine, the throttle valve being provided with cam surfaces which, in certain positions of the valve, prevent movement of the piston and flaps. The invention consists in

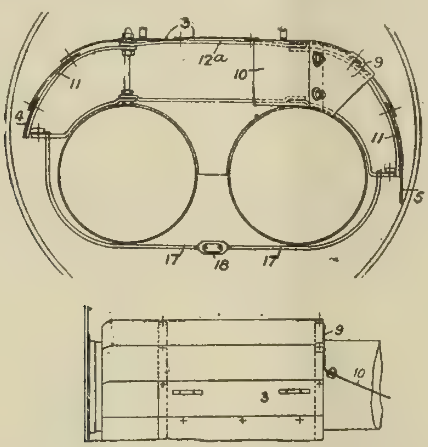
replacing the flaps by a cone and in modifying the cam-surfaces on the throttle valve. The nozzle 13 is fixed and forms a guide for a piston 8, which carries a cone 11, is loaded by a spring 9, is subject to suction through a passage 10, and carries a rod 19 provided with a head 20, Figs. 2 and 3. The throttle-actuating lever 3 has a slot 21 in which is adapted to slide a block 22 loaded by an adjustible spring 23 and carrying a cam 25. The throttle is shown in the closed position in Fig. 3, and the cam 25 is then clear of the head 20. As the throttle is opened, the cam comes under the head 20 and the piston 8 is subjected to the action of the spring 23 as well as that of the spring 9. A cam 26 on the throttle limits the upward movement of the piston 8 and therefore the minimum area of the air passage 18 around the cone 11. Stops 31, 32, Fig. 3, limit the movement of the throttle. Air is admitted to the cone 11 and space 18 through apertures in the casing and apertures 17 respectively. When the throttle is nearly closed, the plate 27 cuts off the passage 10 from the suction; when completely closed, a port 29 again opens up the passage 10; a longer port in the plate 27 keeps the passage 10 open for the remaining positions of the throttle valve.

ALLOYS.

118,825.—F. MILLIKEN, 55, John Street, New York, U.S.A.—May 17th, 1918.—A non-corrodible alloy suitable as a substitute for bronze and brass contains 60 to 70 per cent of copper, 6 to 9 per cent of nickel, 4 to 6 per cent of iron, 12 to 16 per cent of zinc, 2 to 3 per cent of lead, and a trace of phosphorus.

STEAM-GENERATORS.

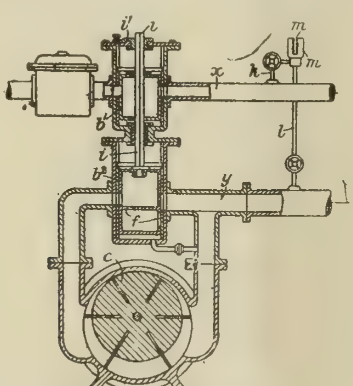
118,858.—PERFECTA BOILER CIRCULATOR LTD., P. C. AYERS, and H. W. E. JOSLING, 39, Victoria Street, London.—June 8th, 1917.—Relates to an inclined hood fitted above the flues for promoting the circulation and having depending side plates and a back plate closing its lower end. The outlet end of a hood is partly



closed on one side by a plate 9, and the side plate 5 on that side extends down into the boiler farther than the side plate on the other side. A longitudinally inclined plate 10 extends forwardly from the plate 9 to deflect the water current towards the opposite side and end of the boiler. The top plates 3 and the curved side plates 4, 5 are bolted to the top bars 11, 12a of frames resting on the flues and secured by cables 17 and adjusting-screws 18.

VALVES.

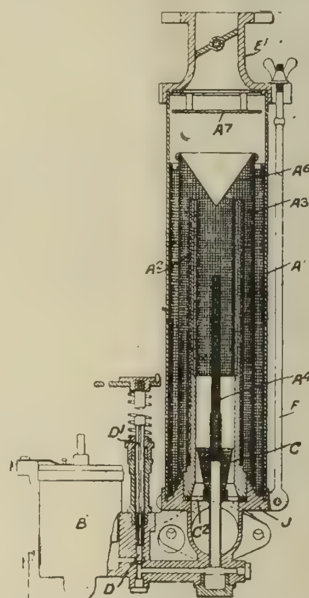
118,870.—SELAS-TURNER Co., Priory House, Priory Street, Coventry, and E. TURNER, Clifton Villa, Westbourne Road, Urmston, near Manchester.—Aug. 9th, 1917.—A valve device for controlling the flow of two or more gases in separate streams is con-



trolled by the outlet pressure of one of the streams to maintain a proportional volume of flow and to maintain the pressure of the governing-stream constant. In the form shown, the piston valves $b1$, $b2$ are mounted on a common spindle i and are actuated by the outlet pressure or suction, or both, of the compressor c acting on the lower valve member. The valves can be rotated by a lever $i1$ in the manner described in Specification 106,296 to vary the proportions of the fluids flowing through the conduits x, y, and the lower valve has a by-pass port f for returning excess pressure to the suction side of the compressor. In a modification ,the two valves are combined to form a single multi-ported valve, and in a further modification, the valves are independently adjustable. The valves may be actuated by a diaphragm. A trial burner m surrounded by a slotted and calibrated tubular fitting $m1$ may be connected to the two pipes by small pipes k, l.

INTERNAL-COMBUSTION ENGINES.

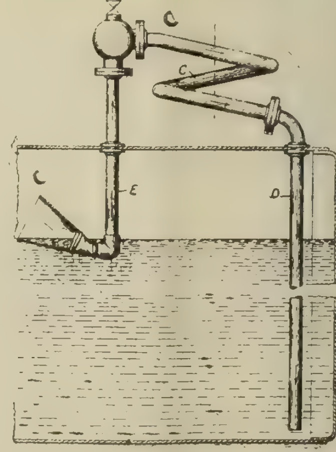
118,861.—A. J. JUNG, 7A, Princes Street, Westminster, and E. B. TREDWEN, 9, Bishopsgate, London.—(E. R. Godward, Don Street, Invergargill, New Zealand.)—June 13th, 1917.—The carburettor is of the type described in Specification 102,043, having an expansion chamber for the mixture lined throughout with absorbent material, and comprises an outer tube A1 secured by clamping-bolts F between a base plate J and an upper cover E1, an inner tube



A2 fitted into the base-plate, both tubes being covered with gauze and absorbent material, and a suction-actuated bell A3 between the tubes and provided with a depending cone A6. The fuel nozzle A4, of gauze, is surrounded by an air valve consisting of a spring coil C, the smaller end of which may be at the top or bottom, and which is secured to a ring C2 and is larger than the nozzle so as to leave a permanently open-air passage. A plate A7 limits the lift of the bell. The flow of fuel from the float chamber B to the nozzle is controlled by a manually-actuated valve D, the spindle D1 of which is grooved to admit air, which ensures equality of level of fuel in the nozzle and float chamber.

STEAM GENERATORS.

118,873.—S. J. WILFORD, 21, Terrace Road, South Hackney, London.—Aug. 13th, 1917.—In syphon apparatus consisting of two



tubes D, E dipping into the boiler and connected together outside, the connection between the tubes is formed by a coiled or zigzag pipe C so disposed that it ascends continuously throughout its length.

— THE —
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CONTENTS.

EDITORIAL.

SKILL AND EXPERIENCE.

IT has been contended, with some show of reason, but with little fundamental fact, that dilution methods intensified by the war are a threat to skill. Methods of production, perfectly feasible for immense quantities of identical articles, cannot be utilised under more normal conditions for more limited manufacture; and although the question of skill has received fresh consideration, and modifications have been introduced, nothing up to the present threatens skill of a real and valid order.

The outstanding possession of skill which differentiates it from mere operation is its ability to transfer itself to novel and unusual work without undue difficulty.

There is all the difference between the mathematician attacking a new problem and the schoolboy performing arithmetical rules by rote; between the skilled mechanic's mentality and that of his untrained competitor. It is not that the mechanic cannot do the work of an operative, but that the operative is confined, perforce, to a very limited area for the exercise of his work. Unless there is this ability to transfer skill without difficulty, there is no way of defining craftsmanship.

No one has had to be more nimble witted and stretch his abilities more than the qualified mechanic during the last four years. He has, in most instances, found that when put on work of quite a different type, he is able very quickly to become master of the new problems. This is, of course, the outcome of his training and a flexible mentality.

There is a little-regarded aspect of the vexed question of dilution and relative skill worth notice. Turn to the advertisements for help in some pre-war file of technical journals and compare these with the current advertisements; visualise the type of questions asked an applicant for employment then and now, and the results are surprising.

If the war has explained anything at all, it is that exact previous experience of a particular type is far less essential, while a flexible mind and trained hand and eye are much more valuable than anyone realised. If a man were wanted for some section of the engineering field, it was the custom to confine consideration to applicants having definite experience along that line, irrespective of the fact whether it would be a hindrance rather than a help. Taking an instance at random: a firm making portable engines would not consider a locomotive man, while a machine-tool shop would not look at any man unless he stepped straight out of another.

Men of skill are at a premium now, their transference being discouraged, so flexible has been found their abilities; any man claiming to be skilled is given quite a reasonable chance to show his form on novel work. To the surprise of many a hide-bound management, to say nothing of the man himself, the stranger from over the border line of a particular field has acquitted himself, not merely well, but with distinction, bringing new light from elsewhere. Owing to shortage, a little more patience and forbearance and some elementary hints have been the rule, and in a week or two the new man shapes up to the job. After all, craft training, like education itself, results in a trained mentality, not in definite experience of a universal character, and this fact is slowly but surely penetrating into hitherto inaccessible places—the minds in management. It will now, and henceforward, be more the rule to enquire whether

a man is trained—not to particular ends—but whether he has the basis without which he cannot develop. In place of hampering the newcomer and giving him the most awkward job in the shop to try his mettle, he will be given a more gradual ascent to prove his ability. Condemnation on very brief trial will become more the exception; it will be recognised that a helping hand must be extended.

Many a firm has lost a first-rate man, firing him as inferior, when, given time, he would have been an asset to the concern. It is to be hoped that post-war advertisements will lay less stress upon prior experience in the peculiar section of effort, and more upon mental muscle and real fundamental ability.

In every direction surprising discoveries have been made, for men, like plants, often benefit from transplanting, and intelligence from outside is apt, proverbially, to see most of the game.

HEAT APPLIED TO ENGINEERING.

By Prof. W. W. Haldane Gee, B.Sc., M.Sc.Tech.

(*Continued from page 89.*)

Thermo-Couples in Commercial Use.

Thermo-couples may be divided into three classes: (1) Base metal, (2) noble metal, and (3) compound metal couples. Examples of the first type comprise copper-nickel, copper-constantan, copper-silver, copper-nickel chrome, nickel chrome-nickel, nickel chrome-cobalt, nickel chrome-nickel aluminium, nickel chrome-nickel copper, and iron-nickel copper. In addition, a number of special alloys are used, more particularly those containing nickel and chromium.

Considerable research has been devoted to the discovery of the best alloys. Two which have been found suitable for higher temperatures gave on analysis:—

	Positive wire.	Negative wire.
Nickel	97.28	88.67
Silicon	2.15	0.15
Iron	0.35	0.10
Aluminium	0.15	0.22
Chromium	0.00	10.75
	99.93	99.89

Noble metal couples are generally either (*a*) platinum and an alloy of platinum containing 10 per cent of iridium, or (*b*) platinum and an alloy of platinum containing 10 per cent of rhodium. Compound couples may consist of two or more couples in series so as to increase the electrical pressure for a given difference of temperature, or may be constructed with short lengths of the noble metal wires attached to longer lengths of the base metals, the object of the last arrangement being to save cost, the expensive noble metals only being used at the place where the temperature would be too high for the more easily fusible base metals.

Methods of Making the Junctions.

For lower temperature work the joint may be soldered, but for high temperature it must be welded by the help of the oxygen-hydrogen or oxygen-acetylene blowpipe flame. An electric arc may also be used.

Annealing of Couples.

If the metals forming the couples are not homogeneous, local or "parasitic" electrical currents will be produced on heating. Thus, if, as shown in Fig. 23, a piece of brass be harder at AB than at AC, and it be heated to a temperature T higher than *t*, which is that at A and C, a current will flow in the direction shown. In the case of steel that is not equally hard, the current flows, as indicated by the arrow in II., in the reverse direction. When platinum wire is twisted into a tangle, a current can be obtained by heating at T, its direction being as shown in III.

To avoid these defects, the couples must be annealed, and kinks avoided. A very convenient method of annealing is by passing an electric current of sufficient strength through the wires to heat them to redness. Equal glowing at all parts is evidence of homogeneity.

Thermo-couples which have been in use for some time are liable to contamination, especially in the region of the furnace end. This may be detected by using two wires (say, copper) placed parallel to each other and keeping them at a constant difference of temperature. The wire to be tested (say, platinum) is placed at right angles to the two wires, good elec-

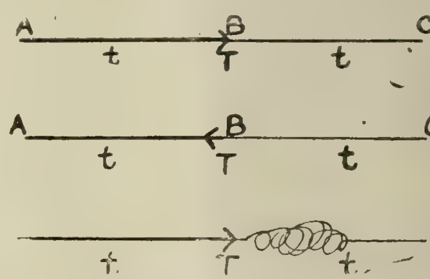


Fig. 23.—Thermo-couples with Single Metals.

trical contacts being secured by pressure. The electrical pressure produced is then measured, and should be the same when the platinum is drawn—step by step—along the copper wires, if no inequality has been produced by contamination or change of physical condition.

Insulation and Protection of Couples.

The wires constituting the couple must be well insulated from each other to avoid short-circuits. In the case of low temperature work, this may be effected by cotton, silk, or glass. The nature of the insulating material for high temperatures will depend upon the temperature that has to be measured. Asbestos and like fire-proof substances may be used. Short lengths of fire-clay or porcelain rods with a double perforation, one for each wire, are often employed.

As a general rule, it is essential to enclose the couple within a suitable tube. This may be of glass, porcelain, or quartz. Frequently an outer tube of steel or other substance is used. There are many methods adopted by the makers of pyrometers for mounting the thermo-couples. The details of one type are shown in Fig. 24. To the hard porcelain head *b*, the terminals *a* are fixed, the wires *c c* constituting the couple (in this case of platinum and platinum rhodium) pass through separate fire-proof

tubes *d d*, and the junction of the wires is at *g*. The fire-proof tubes are enclosed within an insulating fire-proof tube of "Marquardt Masse" (a high-grade type of porcelain), which latter is within an oval Mannesmann steel tube. Fig. 25 shows the complete arrangement. The oval steel tube is $\frac{7}{8}$ in. by $\frac{3}{8}$ in. in diameter, and the length may be about 20 to 60 inches. The price, with platinum-platinum rhodium wires, is high, and depends upon the length and size of wire used. In the above couple the wire used is either 0.55 or 0.6 millimeter in diameter. For permanent use it is advised to protect the couple further by a second steel tube, which can be replaced by a new one when it shows evidence of corrosion. The above type has been designed for temperatures up to 1,600° C. The porcelain tubes are liable to crack if too suddenly heated or too quickly cooled. To guard against this a protecting sheath of a refractory material called "silidur" has been found effective.

Pure fused silica, quartz, glass, or vitreosil has become of importance in mounting thermo-couples,

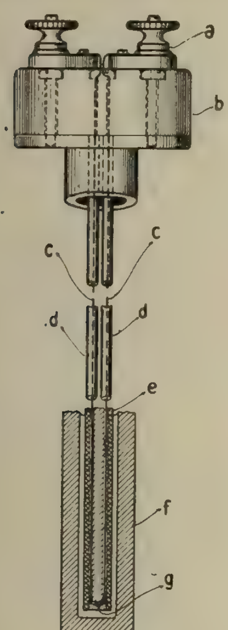


FIG. 24.—SECTION OF THERMO-COUPLE (Budenburg Co.).

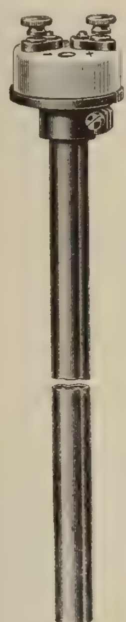


FIG. 25.—PROTECTED THERMO-COUPLE (Budenburg Co.).

owing to its special properties. Vitreous silica is manufactured as a transparent glass, or as an opaque or semi-transparent material. The latter kinds are suitable for pyrometers, for they do not require a transparent material. It softens at about 1,500° C., and melts at about the same temperature as platinum (1,760° C.). When subjected to prolonged heating at about 1,300° C. it loses strength and finally crumbles, hence it should only be used at such temperatures for tests of short duration. At high temperatures it becomes porous to hydrogen, but not to air. As an insulator, it is much superior to glass and porcelain, and its resistance decreases relatively slowly with rise of temperature. Its coefficient of expansion is only about 1-7th that of glass, so that it can be subjected to very rapid changes of temperature without risk of fracture. It is unattacked by acids, with the exception of hydrofluoric acid; and at high temperatures by phosphoric acid, but is dissolved by alkalies.

For pyrometers, vitreosil is made in the form of capillary tubes for the insulation of the wires of thermo-couples, and in thin tubes for the outer protecting sheaths. The lag of temperature is much less than with porcelain, enabling readings to be made more rapidly. With an outer tube of quartz,

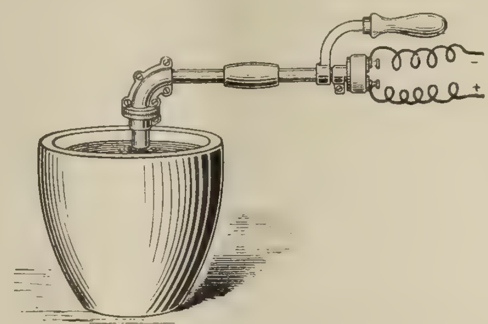


FIG. 26.—THERMO COUPLE WITH ANGULAR FITTING. (Budenberg Co.)

pyrometers may be used in places where steel would be rapidly oxidised. They are also suitable for immersion in fused salts and certain fused metals. For the latter purpose the angular coupling, as shown in Fig. 26, is convenient. On account of its fragility, it is advisable to protect the quartz with a steel sheath, whenever this is possible. The safe limit of temperature with quartz tubes in continuous use is about 1,000° C.; above this temperature they may be permeated by gases which will contaminate the couple.

For temperatures up to 1,350° C., Messrs. Siemen have tested temperature measurements of baths of molten metal and metallic salts by the use of double iron tubes, the inner one being nickel-plated. They find that gases generated in the bath penetrate the outer tube, but not the inner plated tube, and so do

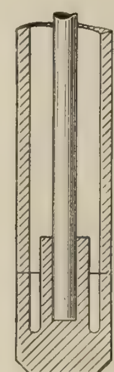


FIG. 27.—POKER TYPE OF THERMO-COUPLE. (R. W. Paul.)

not reach the wires, which may be insulated by porcelain cylinders or balls bored with two holes. This is found better than using an inner porcelain tube, which always causes considerable lag behind the true temperature.

When steel protectors are too rapidly destroyed, resource may be made to certain fireclay and graphite compositions. A graphite tube united by a steel sleeve to an upper steel tube may be used. Car-

borundum sheaths are suitable for very high temperatures. They are, however, attacked by basic slags.

The terminals of the couple should be protected as much as possible from the source of heat. This may be secured in some tests by the use of the angular coupling, as shown in Fig. 26.

The great cost of platinum and its alloys has given an impetus to the study of base metal couples, and if the temperature to be measured is under 1,000° C., certain types can be advised for technical use. The thermo-electric power of such couples is much greater than that with the noble metals, and the cheapness of the material enables couples of low resistance to be constructed. This results in relatively strong currents being produced, so that galvanometers of robust construction can be used, which is a great consideration in industrial practice.

The simplest type is that known as the "poker," as shown in Fig. 27. It consists of an outer tube, ½ in. diameter, made of iron. Within is a rod of eureka (constantan), welded at the furnace end to the iron tube, and insulated elsewhere by steatite and magnesia. The length of the poker is usually about 3 ft. Connections are made to the galvanometer by a concentric coupling furnished with flexible leads.

(*To be continued.*)

A CASE OF DISINTEGRATION OF A COPPER-ALUMINIUM ALLOY.*

By Richard Seligman and Percy Williams.

A large consignment of scrap aluminium wire netting was recently received for remelting. The bulk of this wire was in a normal state, but interspersed with it were a number of wire frames which showed unusual signs of disintegration. The surface of the wire (Fig. 1, A) seemed to have broken up into a number of loosely adhering grains up to 10 mm. in length uniformly inclined to the axis of the wire. On removing the loose grains a solid core of wire was disclosed (Fig. 1, B), which was found by analysis to contain:—

	Per Cent.
Silicon	0·33
Iron	0·30
Copper	2·65 (2·66)

It is considered that this may be taken to have been the composition of the original wire. A sample of the other wire which had not suffered disintegration gave the following figures, which are believed to be substantially representative:—

	Per Cent.
Silicon	0·24
Iron	0·22
Copper	0·07

The wire had been used for a number of years solely for supporting thin slabs of gelatine which are said to be free from all chemicals, with the exception of small quantities of hydrogen peroxide, and both the disintegrated and the unchanged wires had been used for the same purpose and for about the same time. The disintegrated wire had apparently been very severely overdrawn, the cord breaking readily when bent at right angles. On annealing the ductility of the core was restored, showing that its brittleness was not due to disintegration. The unchanged wire was soft.

The grains were coated with a grey substance, presumably alumina, but when washed with concentrated nitric acid the coating was largely removed and the metallic surface of the grains was exposed.

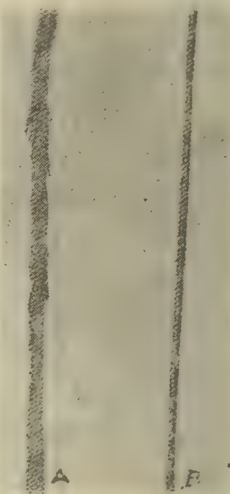


Fig. 1.
Disintegrated Aluminium Wire.
(Slightly magnified.)

Under magnification of 30 diameters (Fig. 2) it was evident that the grains were composite, and on warming them with dilute nitric acid they were further resolved into what were in all probability the ultimate grains, the largest of which was about 0·1 mm. long (Fig. 3).

A number of cases of the disintegration of aluminium and its alloys have been cited, but in most instances very little detailed information is given. An exception is formed by a paper by H. Le Chatelier,* who apparently had some material very similar to that now described through his hands. Le Chatelier's observations were made upon sheet metal, the composition, state, and history of which are not given in his Note.

Fig. 2.
Disintegrated Aluminium Wire.
Large grains. × 30.
(Reduced by one-third.)

* Paper read before Institute of Metals.

* *Revue de Métallurgie*, viii. 373 (1911).

In the present instance two causes have probably contributed to the disintegration—namely, the excessive work put upon the wire in the first instance, and the copper with which it was, no doubt unintentionally alloyed. In this connection it is not without interest to refer to a statement of Carpenter and Edwards in the "Eighth Report of the Alloys Research Committee of the Institution of Mechanical Engineers," p. 254. Describing a slowly-cooled alloy of aluminium with 4·97 per cent of copper, Carpenter and Edwards suggest that it consists of crystals which are probably nearly pure aluminium around which the copper-aluminium eutectic is distributed as a cement. If this suggestion were correct the cause of the form which the disintegration had taken in the

FIG. 3.
Disintegrated Aluminium Wire.
Small grains. × 30.
(Reduced by one-third.)

case under discussion might be found in the dissolution of this eutectic, leaving the crystals or grains unattacked. The grains should then differ in composition from the unchanged wire, and would, if Carpenter and Edwards' hypothesis were fully correct, be found to be free from copper.

By analysis it was possible to establish the fact that there was a very definite difference between the copper content of the grains which had been warmed with dilute nitric acid and of the unchanged core, but that the grains were far from being pure aluminium. The copper content of the grains was found to be 2·49 per cent (2·48, 2·49), and that of the core of unaltered wire 2·65 per cent (2·66).

The writers wish to express their thanks to Professor Carpenter and Miss Elam for their kindness in having the photographs that are used to illustrate this Note prepared.

EFFECT OF LOW-TEMPERATURE OXIDATION ON THE HYDROGEN IN COAL.

THE U.S. Bureau of Mines Technical Paper 98 contains particulars of investigations on the above subject carried out by S. H. Katey and H. C. Porter. Most of the work of previous investigators of the oxidation of coal as related to the hydrogen of the coal substance was at the temperature of boiling water and above. The results varied widely, probably due to the absorption of gas by the coal on drying. Mahler has given trustworthy data showing that in low-temperature oxidation hydrogen is evolved from coal in the form of water. In the apparatus used by the authors, nitrogen or air passed from a drying train through a large quantity of coal at room temperature, thence through another drying train which caught the water given up by the coal. The weight of water and the change of weight of the coal were then ascertained. When nitrogen was passed through the coal there was invariably a loss in weight, much less, however, than the weight of water evolved from the coal. The small amount of oxygen in the nitrogen is not sufficient to account for the discrepancy, which may be due to absorption of nitrogen by the coal. When air was passed through there was always a gain in weight despite the loss of water. Analyses of the coal before and after the experiments showed an increase in oxygen content and a corresponding decrease in other constituents, but no loss of hydrogen could be shown by these analyses. No evidence is afforded that water is produced by the oxidation of coal at ordinary temperatures.

THE COST OF RAILWAY ELECTRIFICATION.

DATA now available covering the conversion from steam to electricity of several railway systems in the United States, show that the cost of conversion in the case of lines with a reasonable amount of traffic is amply justified from the financial standpoint. The Butte Anaconda and Pacific Railway, which was electrified in 1913 at an initial cost of £248,126, showed a total net saving per year over steam operation of £49,758, exceeding 20 per cent upon the entire cost of the electrification. In addition to this definite money saving, the railway, according to the report, secured a greatly increased capacity and a much improved service, and these facts having been well acknowledged, the indications are that the Federal Government will take steps to conserve the existing supply of coal and fuel oil by assisting to finance such electrification as competent engineering authorities are able to show will make the greatest saving in fuel. In order to establish a definite ratio of comparisons between the efficiency of the steam locomotive and the electric system, data have been compiled showing that, as an average figure, 7 lb. of coal on the tender of a steam locomotive on the electric system is equivalent to a kilowatt-hour of electricity in the alternating current switch-board of the power-house. A kilowatt-hour of electrical energy can be produced in a modern plant with $2\frac{1}{2}$ lb. of coal, the deduction therefore being that it requires 7 lb. of good coal in a locomotive fire-box to haul the same amount of net tonnage as could be dealt with by an electric locomotive burning $2\frac{1}{2}$ lb. of coal in an up-to-date power-house.—*Railway Gazette.*

A process for forming castings of certain non-ferrous alloys is announced by the Morris Engineering Company, 39, Cortlandt Street, New York. It consists in pouring the molten alloys into metal moulds, and forming or congealing the castings under pressure. They are really die castings formed under high pressure. A large number of fuse bodies for shrapnel have been made in this way, the composition being 80 per cent of aluminium, and 20 per cent of zinc. An automatic machine is used. The tensile test and elastic limit figures of several castings of different alloys so made are quoted. An interesting result of the process is the making and handling of an alloy of aluminium, copper, and iron, which has a low coefficient of expansion. The manufacture, under the process, of pistons, of this alloy, for high-power aircraft engines is contemplated.

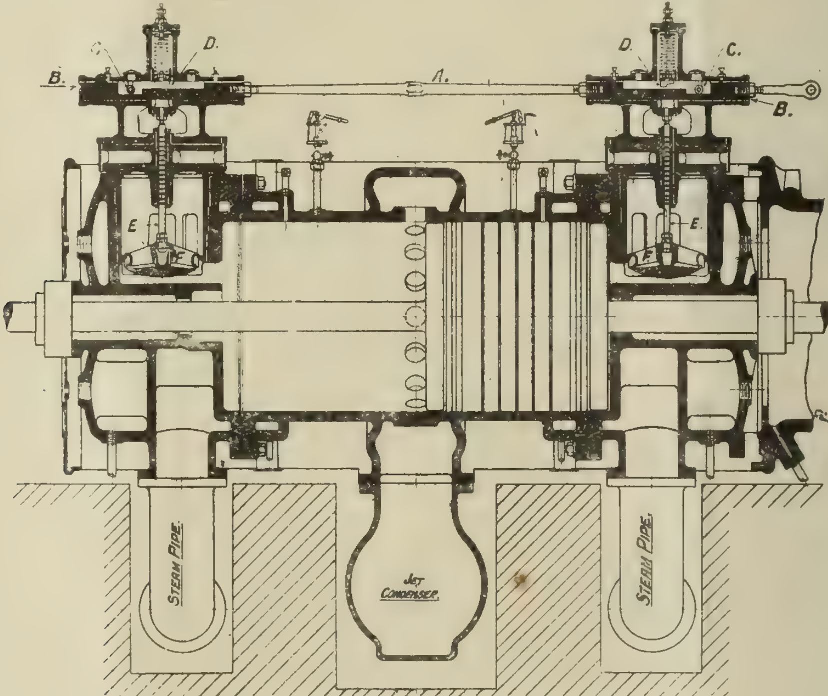
THE UNAFLOW STEAM ENGINE.

By D. H. Yates.

(*Continued from page 75.*)

Cylinder and Cylinder Fittings.

Fig. 5 illustrates a longitudinal section through a Unaflow cylinder, with the steam valves and bonnets in position, and also the condenser, which in this case is of the jet type. A is the coupling rod to which is attached at each end a sliding bar B containing a roller C. A receives a reciprocating motion by means of connections through another rod, rocking lever, and eccentric rod, to a crank-shaft governor fitted with a compound eccentric which controls the action of the steam valves and the speed of the engine. As B slides along, C comes in contact with a cam D connected to the valve spindle E on the top end of which there is a spring dashpot. C, whilst moving inwards towards the centre of the cylinder, lifts D and opens the steam valve F, thereby admitting steam to the cylinder. On the return stroke of C it leaves D at a certain fixed point, and the steam valve is closed by means of the spring.



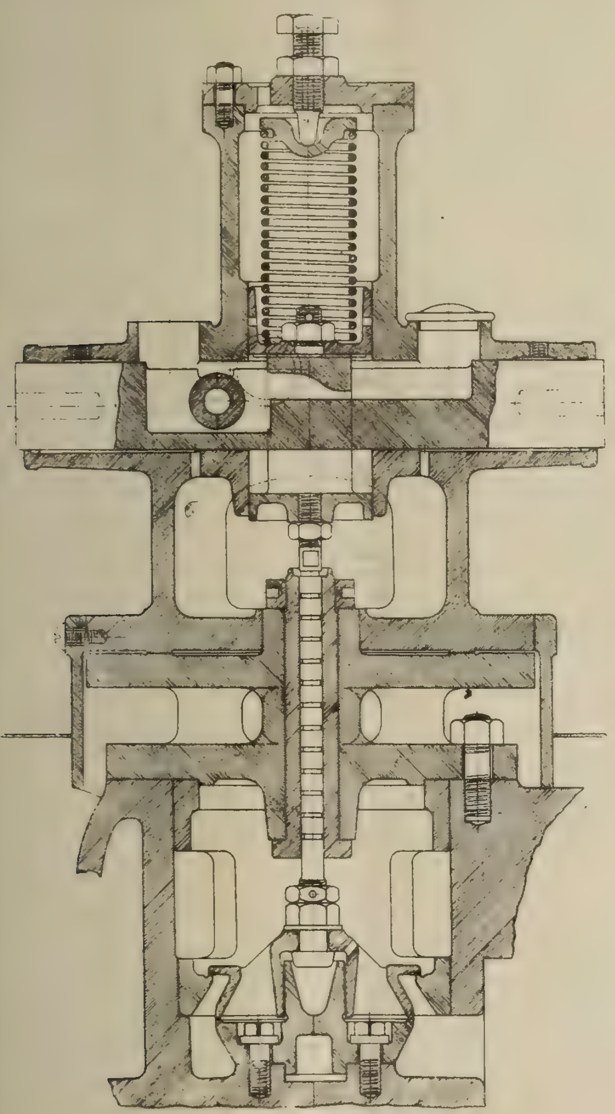
Unaflow Steam Engine.—Fig. 5.

Fig. 6 shows an enlarged detail of the valve and valve bonnet. Referring again to Fig. 5, it will be seen that live steam is admitted to the valve box at each end of the cylinder by means of the steam pipe at the bottom, and so finds its way to the steam valve at the top of the box. The valve box is therefore always full of steam when the engine is working, and live steam is constantly passing through the box. By this means a very effective steam jacket is formed for the cylinder end, thus reducing cylinder condensation. It will also be noticed that the extreme ends of the cylinder barrel are formed in the valve boxes themselves, and so the boxes also form a steam jacket for the barrel ends as well as for the cylinder ends or valve box faces.

The Cycle of Operation.

Let us assume that we are starting out with a boiler pressure of 160 lb. or 170 lb. per square inch, which are pressures commonly used nowadays. It is obvious that a large range of expansion will be required in a single-cylinder condensing engine in order to expand the steam down to a suitable terminal pressure, which should be below the atmospheric line. This necessitates a cut-off of about 8 per cent for normal working. Professor Stumpf makes the following statement: "With a 2 per cent clearance, cut-off at 8 per cent, condenser pressure 0.07 atmosphere absolute, the most favourable compression is 90 per cent, and these conditions may be taken as normal for the Unaflow engine," *i.e.*, compression commences at 10 per cent of the exhaust stroke, and this produces excellent running. The period of compression being fixed, the point of release is thus automatically fixed at 90 per cent of the steaming stroke owing to the construction of the cylinder, and the exhaust ports only remain open for 10 per cent of the steaming or expansion stroke, and 10 per cent of the exhaust or compression stroke. To obtain a release at 90 per cent of the steaming stroke and compression at 10 per cent of the exhaust stroke of the engine, the depth of the piston is made 90 per cent of the length of the stroke. Thus, for a stroke of 30 in. the piston would be 27 in. deep, for a stroke of 40 in., 36 in. deep, and so on. This arrangement then brings the length of the exhaust ports in the barrel to 10 per cent of the stroke length, and these ports being placed at intervals round the circumference of the barrel form an extremely large exhaust valve liner, the piston itself acting as the exhaust valve and being operated by the crank. The exhaust ports can be made with an area of three times those

of a counterflow engine, and so the steam gets away quite easily through the ports to the condenser in the short period of time during which the ports are open. By connecting the condenser directly to the exhaust branch of the cylinder, which is the method usually adopted, an exhaust branch of even larger area than that of the exhaust ports can be used, thus eliminating all exhaust pipes of restricted area between the cylinder and condenser, and giving a vacuum in the cylinder practically equal to that in the condenser, which result is never obtained with a compound engine. The same result in this respect

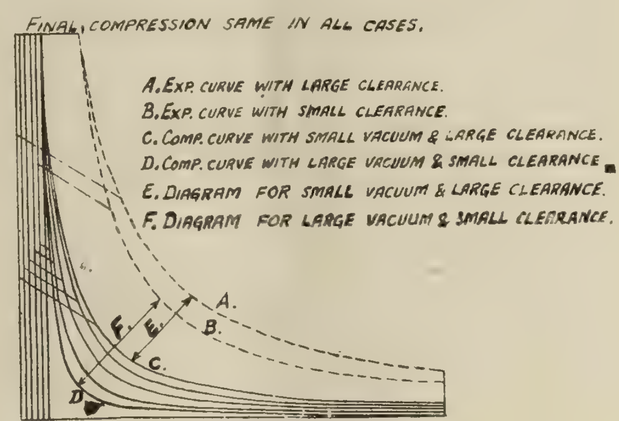


Unaflow Steam Engine.—Fig. 6.

could, of course, be obtained with a compound engine by the introduction of abnormally large exhaust valves and pipes, but the consequent losses in other directions, mainly due to increased clearance volumes and surfaces, would more than nullify the advantage thus gained.

The Advantage of Small Exhaust Pressure.

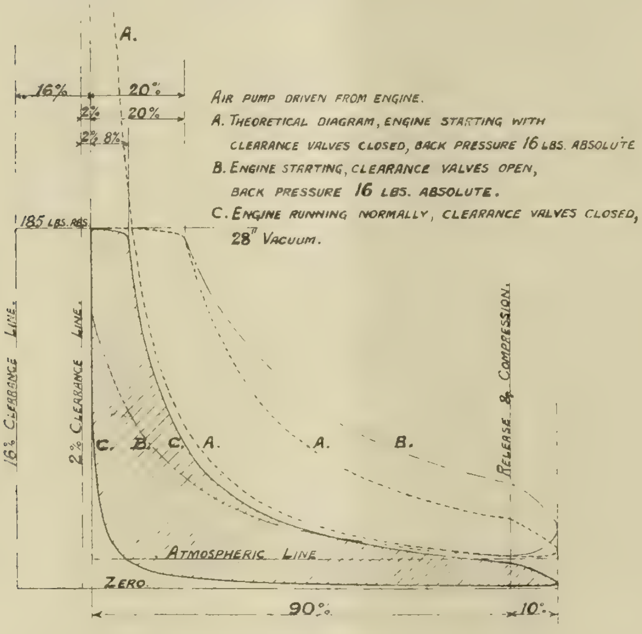
The great advantage derived from the use of a small exhaust pressure in the cylinder is soon seen by examination of Fig. 7. This figure illustrates the compression curves which would be obtained by compressing up to a fixed final pressure, but with varying initial compression pressures, together with the varying clearance volumes required to fulfil the conditions laid down. By comparing the two extreme compression curves C and D together with their respective steam expansion curves A and B, forming the two complete diagrams E and F, it will be seen that the area of diagram F is considerably more than the area of diagram E. As F is the diagram obtained by the introduction of a large vacuum and small clearance space, the advantage gained is clearly demonstrated. Summarising the foregoing, we find that steam is admitted to the cylinder for 8 per cent of the stroke and is then cut off by the closing of the valve, the valve gear being positively operated without trip motion. The steam then expands down to 90 per cent of the stroke, and at this point the piston uncovers the exhaust ports and release commences, the ports being closed again for compression at 10 per cent of the return stroke, the compression continuing for the remaining 90 per cent of the return stroke until we get to the point of admission again. No lead is required on the steam valve, as better running is thus obtained. Sometimes a small lead is obtained, but in any case this is so small as to be negligible,



Unaflow Steam Engine.—Fig. 7.

and does not affect the actual running. Up to the present we have only dealt with the Unaflow engine as a condensing engine, but when starting up from rest it has to fulfil the conditions of a non-condensing engine for a few revolutions until the air pump and condenser get working to their full extent, provided that the air pump is driven from the engine. We now find the conditions greatly altered as indicated by Fig. 8, for with an exhaust pressure above that of the atmosphere at the start of the engine, and a clearance volume of only 2 per cent, we find that if we commence compression at 10 per cent of the exhaust stroke, that the final compression pressure will be far in excess of the boiler pressure, which might result in a breakdown. To get over this difficulty, an additional clearance space must be provided temporarily. This is obtained by the provision of what is known as a clearance-space valve which, on being opened, connects the cylinder end with an enclosed space arranged in the valve box on the side furthest away from the cylinder. When not in use, this space acts as a non-conducting medium on the outside of the steam chest. The Unaflow engine can work quite easily as a non condensing engine by providing a permanent additional clearance space,

which is often done by making the ends of the piston concave, as will be seen later. The clearance volume is dependent on the pressure and temperature of the admission steam, decreasing as the initial pressure increases, and increasing with increase of temperature by superheating. With a condensing engine, the clearance-space valve should be opened preparatory to starting the engine, and should be closed again immediately the engine has attained its speed and vacuum. In Fig. 8 the dotted line A indicates what would take place theoretically in a Unaflow condensing engine cylinder when starting, assuming that the clearance-space valves were left unopened; boiler pressure 170 lb. per square inch (185 lb. absolute), cut-off of 20 per cent (this being a common cut-off at starting), initial compression pressure 16 lb.



UNAFLOW STEAM ENGINE.—FIG. 8.

absolute, clearance space 2 per cent. The abnormal final compression pressure will be noticed. The chain lines B indicate what actually takes place when starting with the clearance valves open, the total clearance now being 16 per cent, other conditions remaining the same. It should be here stated that this total clearance volume of 16 per cent is usually exceeded in practice when only used for starting purposes. The full lines C indicate the normal running of the engine with clearance-space valves closed and with 170 lb. boiler pressure, 8 per cent cut-off, 28 in. vacuum, and 2 per cent clearance volume.

A NEW THEORY OF PLATE SPRINGS.

By DAVID LANDAU AND PERCY H. PARR.

(Continued from page 106.)

The number of vibrations required to break the one-leaf spring having been determined, we may now propose the problem of constructing a spring to carry twice the load, or 2P, and to deflect the same distance d, and also to withstand the same number of vibrations as before. How should we, in accordance with the present-day theory, make a spring to fulfil these requirements, it being understood that the length l must not be altered? The answer of the present-day theory is given by Fig. 3.

A second leaf, called the short leaf, and in this case having a length $\frac{1}{2}\delta_2$, would be placed under the original leaf. The prevailing theory advises that the resulting spring of Fig. 3 will support, with equal safety and equal deflection, a load of double that of our original one-leaf spring, or 2P if the load for the single leaf is P.

Again, the theory in common use to-day indicates that the spring to carry 3P must be made as shown

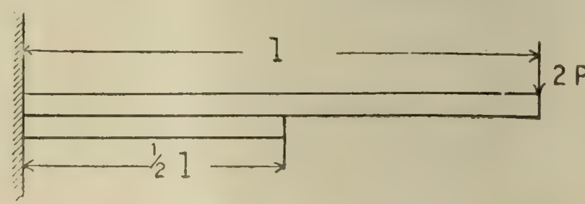


PLATE SPRINGS.—FIG. 3.

in Fig. 4, where it will be seen that the second leaf has a length of $\frac{2}{3}l$ and the short leaf a length of $\frac{1}{3}$ l. In general, this theory assumes that "the number of leaves is directly proportional to the load." It should be noted that the "steps" or "overhangs" are all equal.

For the present we are considering only springs composed of leaves of the same cross-section; later on we shall discuss the effect of varying the sections, or "grading" the springs.

Now, suppose that we consider a spring such as that shown in Fig. 4, and ask if the stresses are the same in all of the leaves, and if the maximum stress in each leaf is the same as that in the simple leaf of

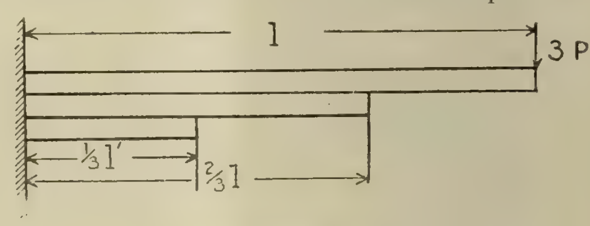


PLATE SPRINGS.—FIG. 4.

Fig. 1. The answer given by those who expound the ordinary theory is about as follows:—

They say (in the case of Fig. 3) that, since the load is doubled, so is the maximum bending moment, the length being the same, and as the section modulus is also doubled, the stress is $\frac{2Pl}{2Z} = \frac{Pl}{Z}$ the same as before. Likewise, at the point $\frac{l}{2}$ the bending moment is $\frac{2Pl}{2} = Pl$, so the stress there is the same as at the point of fixation. An exactly similar line of reasoning is applied to Fig. 4, and so on for any number of plates.

If we accept these statements as true—and the deductions are correctly made from the original assumption of the theory—then we must expect, *a priori*, that in any such spring each and every plate is liable to the same mathematical probability of concomitant failure.

How far is this concept verified by experiment? This is the crucial test to which all mechanical theories must submit; and any failure of a theory to explain the test results in a satisfactory matter is a proof of its inadequacy. The experimental verification of the theories of leaf springs was made possible by the endurance testing machine.

Imagine that we have constructed springs of, say, 2, 3, 4, . . . , etc., plates, the master leaf* being the same length in each spring, and all the leaves having the same cross-section; also that we put these springs into a vibratory testing machine, making each deflect the same distance *d*. What will happen? Since we have conducted exactly such a series of tests, we are able to give a definite reply to this question.

We tested 33 springs containing 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and 13 plates. All these springs were carefully constructed so as to reduce accidental errors to a minimum. The results of these tests were most astonishing; in each case (except two only) only one leaf in each spring broke, and the broken leaf was always the shortest one! Why? In accordance with the usual theory, all the leaves composing the spring—or at least several of them—should have broken at one and the same time, and the liability of each leaf to fracture should be exactly the same, so that with our considerable number of tests we should have had broken leaves in many positions in the springs. Why this enormous deviation from the results predicted by the theory? We must add another observation of great importance: in no

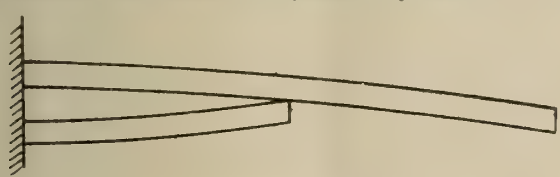


Plate Springs.—Fig. 5.

two cases were the number of vibrations required to break the short leaf the same; on the contrary, the number of vibrations required to break the short leaf decreased as the number of leaves in the spring increased.

Here we have the results of careful experimental work which seemed to indicate the reverse of the theoretical prediction—a theory which has not been questioned since it was first proposed, probably in 1852—66 years ago! Various explanations were offered to account for the results, and among them the one which appeared to be the most logical and reasonable follows.

Consider, for simplicity, a two-leaf spring such as that shown in Fig. 3, and suppose it to be so constructed that when it is not loaded, or, as we prefer to term it, "free," it is perfectly flat (if arched when free, it does not materially change the reasoning). Now, it is well known to engineers that in the making of a spring each leaf is given a different radius of curvature, as shown roughly by Fig. 5. When the leaves are clamped together by the centre bolt, note that the leaves are deflected in opposite directions; the master leaf is deflected upward at the ends, or in the opposite direction to the deflection caused by the external load, while the short leaf is deflected downward, or in the same direction as the deflection caused by the external load. As a consequence, it follows that the short leaf of a spring, no matter what the number of leaves, is thereby already loaded positively. Similarly, the upper leaf is unloaded or loaded negatively. These initial loading and unloading effects produced by the method of manufacture are present in all commercial leaf springs, though in different degrees.

This method of building leaf springs with initial deflections of the separate lamina, technically called "nip," helps the old theory to explain the breaking of the short leaf first. For it is argued, and reasonably, that, since the short leaf is already positively stressed by the nipping load, this stress must be added to that produced by the external load, with the result that the short leaf has the greatest stress in it, and will therefore be the first to break. This appears to be a fair explanation of one of the facts brought to view by the destruction tests; but when put to a further test, however, the explanation fails utterly. (*To be continued.*)

* The longest leaf of a spring, usually having eyes rolled or forged at the ends, is technically called the "master leaf," "main leaf," or "back."

ECONOMIES IN THE GENERATION AND USE OF STEAM.

By Sidney F. Walker, R.N., M.I.E.E., M.I.M.E.

(*Continued from page 51.*)

The Behaviour of the Circulating Water in the Tubes.

One of the difficulties of maintaining vacua, whether high or low, in surface condensers, is due to the possibility of the formation of a deposit of oil on the steam side, and of salts on the water side of the tubes. The deposit of oil will not occur with the exhaust from steam turbines, unless there is great carelessness in looking after the turbines; no oil is required inside the turbine itself; that is one of its great advantages, and unless some is allowed to come over from the bearings, there should be none in the steam. With reciprocating engines, however, the matter is quite different, and particularly since superheated steam has been employed; a lubricant is absolutely necessary, and with the high temperatures due to superheating, only mineral oils can be employed; and a small portion of the lubricant is vaporised and carried forward with the steam into the condenser, unless a separator is interposed in its path. In the condenser the oil condenses, and is usually deposited upon the outsides of the condenser tubes. The eminent practical steam engineer referred to in a previous part of the article, has estimated that the thermal resistance of a deposit of oil $^1/_{100}$ in. in thickness is equal to that of $^1/_{10}$ in. of scale, and a plate of steel 10 in. thick. It will be seen from this how easily the efficiency of the condenser may be lowered. The effect of the salts often carried in solution in the circulating water may easily be as serious, by their deposit on the insides of the tubes. The remedy is, of course, to keep the tubes clean both on the inside and the outside; the writer would suggest also that the engineer in charge should keep in touch with every part of his condenser, right through the twenty-four hours, in the same manner as suggested in a previous

article for the boiler. For efficient working, with a given vacuum, and a given quantity of steam passing into the condenser, certain definite temperatures should rule in different parts of the condenser; and by fixing recording electrical thermometers in each part the engineer should have complete command of the working of his condenser. If a thermometer is placed near the inlet, and another near the outlet of the circulating water, for instance, the record should be a good guide as to the thermal resistance between the circulating water and the steam; if a recording thermometer is also fixed half way in the circuit of the cooling water a further guide should be obtained as to the thermal resistance in the two halves of the condenser. If the condenser is divided into more than two portions, as some modern condensers are, recording thermometers might be placed between each division. There will be a certain difference of temperature between the inlet water and the outlet, and also between the water in each division of the condenser. If there has not been the proper fall of temperature between the inlet and outlet of the circulating water, or between either and any division of the condenser, while the same quantity of steam has been dealt with during any given period, the proper transference of heat from the steam to the cooling water is not taking place, and the cause must be looked for. If there are thermometers between every division the trouble should be more easily located. When the tubes are clean both inside and out, with an initial temperature of cooling water at a certain figure, there will be a certain definite increase of temperature after the cooling water has passed through each division. If that increase has not taken place, there is not the proper transfer of heat to the cooling water in that division. If the rise of temperature is less than it should be through all divisions, the cause will probably be common to all of them, and very possibly an even deposit either on the inside or the outside of the tubes, or both, all the way through.

A Reference to Cold Storage Practice.

Perhaps a reference to cold storage practice will be interesting here. It has a very important bearing upon the question of the transfer of heat from air, etc., at a higher temperature to a liquid at a lower temperature. In the steamers which bring chilled meat from the Argentine, the isolated holds are divided into sections, each section having its own pipe or pipes, through which cold brine is circulating. All the pipes have their return at a tank near the engine room, and the outflow from each pipe has a thermometer embedded in it in such a manner that the attendant can easily read the temperatures. It is very important, when carrying chilled beef, that the atmosphere of the hold should not fall to a figure at which the meat would be frozen. A few minutes of freezing temperature may do a great deal of harm, consequently, the attendant at the tank keeps his eye constantly on the thermometers in the outflow from each section of the hold. If there is a large rise of temperature in any one outflow, it indicates that there is too great a transference of heat from the atmosphere of the section of the hold supplied by that pipe to the brine, and the flow of brine is immediately lessened.

Similarly, in the steam condenser, if non-recording thermometers of the mercury type are fixed in different portions of the circulating water circuit, any decrease in the transfer of heat from the steam to the tubes can be temporarily provided for, and the vacuum maintained by increasing the velocity of the cooling water.

Recording, or fixed thermometers at the steam inlet, the air outlet, and the condensate outlet will enable the engineer to keep in close touch with what is taking place on that side of the condenser service. Thermometers in different parts of the boiler feed-water circuit will give also very valuable information, especially if recording thermometers are employed and the sheets are kept and analysed, and a book kept of the results.

Any lowering of the temperature of the condensate should be immediately noted, and the cause inquired into, also any rise or fall in the temperature of the air and gases being exhausted by the air pump.

Increased Economy.

It will be understood that all the instruments which are being recommended in these articles will cost money, and that keeping the proper checks and records will also cost money. They will, however, more than pay for themselves by increased economy in the running of the plant. These records are the equivalent of the book-keeping that is so necessary on the commercial side of any undertaking. Good book-keeping enables economies to be made by revealing where waste is taking place, or where it is possible to reduce costs. It reveals, also, or should do, where false economies are made, and this is what the writer suggests the different instruments and their records should do for the working of boiler and steam condenser plant. As every manager of a works knows, there are numerous inventions on the market, each one of which is calculated by the inventor to effect a certain economy. In too many instances the engineer has no means of checking the inventor's statements, because he does not know what any particular part of his apparatus is costing him to run, in heat units, or in cash. If he has complete records of the working of every part of the steam plant he can check the working, and reduce the costs to the lowest possible figure. The books made up from the analyses of the different records of the different instruments should enable him to see where heat units are being wasted, just as the accountant is able to see where pence, or fractions of a penny, that mount up to a large total when multiplied, can probably be saved. That great bugbear of the old-time condenser, air leakage, should immediately give indications of its presence, and of its steady increase, if proper thermo-metrical records are kept and analysed. Records should also be kept of the pressures in the steam space, and these should also be recorded and analysed. The writer understands that there is an apparatus on the market be kept of the pressures in the steam space, and these of making the usual correction for difference in the barometric pressure.

(To be continued).

Messrs. Cammell, Laird, of Birkenhead, are at present engaged upon the construction of an electrically-welded ship. The experiment was decided upon as the result of investigations and tests made under the supervision of Sir George Carter, the managing director of the firm. The vessel is of the coasting type, 150 ft. long. She will carry 500 tons deadweight, and have cargo capacity of 26,000 cubic feet.

Weights of Lengths of Rolled Steel Sections.

Beam 8 in. × 8 in. × 37 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 1 6	6 2 12	9 3 18	13 0 24	16 2 2	0 19 3 8	1 3 0 14	1 6 1 20	1 9 2 26	0
1	0 1 9	3 2 15	6 3 21	10 0 27	13 2 5	16 3 11	1 0 0 17	1 3 1 23	1 6 3 7	1 10 0 7	1
2	0 2 18	3 3 24	7 1 2	10 2 8	13 3 14	17 0 20	1 0 1 26	1 3 3 4	1 7 0 10	1 10 1 16	2
3	0 3 27	4 1 5	7 2 11	10 3 17	14 0 25	17 2 1	1 0 3 7	1 4 0 13	1 7 1 19	1 10 2 25	3
4	1 1 8	4 2 14	7 3 20	11 0 26	14 2 4	17 3 10	1 1 0 16	1 4 1 22	1 7 3 0	1 11 0 6	4
5	1 2 17	4 3 23	8 1 1	11 2 7	14 3 13	18 0 19	1 1 1 25	1 4 3 3	1 8 0 9	1 11 1 15	5
6	1 3 26	5 1 4	8 2 10	11 3 16	15 0 22	18 2 0	1 1 3 6	1 5 0 12	1 8 1 18	1 11 2 24	6
7	2 1 7	5 2 13	8 3 19	12 0 25	15 2 3	18 3 9	1 2 0 15	1 5 1 21	1 8 2 27	1 12 0 5	7
8	2 2 16	5 3 22	9 1 0	12 2 6	15 3 12	19 0 18	1 2 1 24	1 5 3 2	1 9 0 8	1 12 1 14	8
9	2 3 25	6 1 3	9 2 9	12 3 15	16 0 21	19 1 27	1 2 3 5	1 6 0 11	1 9 1 17	1 12 2 23	9

Weight of Beam, advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	3·08	6·16	9·25	12·33	15·42	18·50	21·58	24·67	27·75	1 2·84	1 5·92	1 9	

Weights of Lengths of Rolled Steel Sections.

Beam 8 in. × 8 in. × 37 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	1 13 0 4	3 6 0 8	4 19 0 12	6 12 0 16	8 5 0 20	9 18 0 24	11 11 1 0	13 4 1 4	14 17 1 8	0
10	0 3 1 6	1 16 1 10	3 9 1 14	5 2 1 18	6 15 1 22	8 8 1 26	10 1 2 2	11 14 2 6	13 7 2 10	15 0 2 14	10
20	0 6 2 12	1 19 2 16	3 12 2 20	5 5 2 24	6 18 3 0	8 11 3 4	10 4 3 8	11 17 3 12	13 10 3 16	15 3 3 20	20
30	0 9 3 18	2 2 3 22	3 15 3 26	5 9 0 2	7 2 0 6	8 15 0 10	10 8 0 14	12 1 0 18	13 14 0 22	15 7 0 26	30
40	0 13 0 24	2 6 1 0	3 19 1 4	5 12 1 8	7 15 1 12	8 18 1 16	10 11 1 20	12 4 1 24	13 17 2 0	15 10 2 4	40
50	0 16 2 2	2 9 2 6	4 2 2 10	5 15 2 14	7 8 2 18	9 1 2 22	10 14 2 26	12 7 3 2	14 0 3 6	15 13 3 10	50
60	0 19 3 8	2 12 3 12	4 5 3 16	5 18 3 20	7 11 3 24	9 5 0 0	10 18 0 4	12 11 0 8	14 4 0 12	15 17 0 16	60
70	1 3 0 14	2 16 0 18	4 9 0 22	6 2 0 26	7 15 1 2	9 8 1 6	11 11 1 10	12 14 1 14	14 7 1 18	16 0 1 22	70
80	1 6 1 20	2 19 1 24	4 12 2 0	6 5 2 4	7 18 2 8	9 11 2 12	11 4 2 16	12 17 2 20	14 10 2 24	16 3 3 0	80
90	1 9 2 26	3 2 3 2	4 15 3 6	6 8 3 10	8 1 3 14	9 14 3 18	11 7 3 22	13 0 3 26	14 14 0 2	16 7 0 6	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight
	16 10 1 12	33 0 2 24	44 11 0 8	66 1 1 20	82 11 3 4	99 2 0 16	115 12 2 0	132 2 3 12	148 13 0 24	165 3 2 8	

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Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam $9\frac{1}{2}$ in. × $9\frac{1}{2}$ in. × 51 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	Ft.
0	..	4 2 6	9 0 12	13 2 18	0 18 0 24	1 2 3 2	1 7 1 8	1 11 3 14	1 16 1 20	2 0 3 26	0
1	0 0 23	5 0 1	9 2 7	14 0 13	0 18 2 19	1 3 0 25	1 7 3 3	1 12 1 9	1 16 3 15	2 1 1 21	1
2	0 3 18	5 1 24	10 0 2	14 2 8	0 19 0 14	1 3 2 20	1 8 0 26	1 12 3 4	1 17 1 10	2 1 3 16	2
3	1 1 13	5 3 19	10 1 25	15 0 3	0 19 2 9	1 4 0 15	1 8 2 21	1 13 0 27	1 17 3 5	2 2 1 11	3
4	1 3 8	6 1 14	10 3 20	15 1 26	1 0 0 4	1 4 2 10	1 9 0 16	1 13 2 22	1 18 1 0	2 2 3 6	4
5	2 1 3	6 3 9	11 1 15	15 3 21	1 0 1 27	1 5 0 5	1 9 2 11	1 14 0 17	1 18 2 23	2 3 1 1	5
6	2 2 26	7 1 4	11 3 10	16 1 16	1 0 3 22	1 5 2 0	1 10 0 6	1 14 2 12	1 19 0 18	2 3 2 24	6
7	3 0 21	7 2 27	12 1 5	16 3 11	1 1 1 17	1 5 3 23	1 10 2 1	1 15 0 7	1 19 2 13	2 4 0 19	7
8	3 2 16	8 0 22	12 3 0	17 1 6	1 1 3 12	1 6 1 18	1 10 3 24	1 15 2 2	2 0 0 8	2 4 2 24	8
9	4 0 11	8 2 17	13 0 23	17 3 1	1 2 1 7	1 6 3 13	1 11 1 19	1 15 3 25	2 0 2 5	2 0 0 9	9

Weight of Beam, advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight
	4·25	8·5	12·75	17·0	21·25	25·5	1 1·75	1 6	1 10·25	1 14·5	1 18·75	1 23	

Weights of Lengths of Rolled Steel Sections.

Beam $9\frac{1}{2}$ in. × $9\frac{1}{2}$ in. × 51 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 5 2 4	4 11 0 8	6 16 2 12	9 2 0 16	11 7 2 20	13 13 0 24	15 18 3 0	18 4 1 4	20 9 3 8	0
10	0 4 2 6	2 10 0 10	4 15 2 14	7 1 0 18	9 6 2 22	11 12 0 26	13 17 3 2	16 3 1 6	18 8 3 10	20 14 1 14	10
20	0 9 0 12	2 14 2 16	5 0 0 20	7 5 2 24	9 11 1 0	11 16 3 4	14 2 1 8	16 7 3 12	18 13 1 16	20 18 3 20	20
30	0 13 2 18	2 19 0 22	5 4 2 26	7 10 1 2	9 15 3 6	12 1 1 10	14 6 3 14	16 12 1 18	18 17 3 22	21 3 1 26	30
40	0 18 0 24	3 3 3 0	5 9 1 4	7 14 3 8	10 0 1 12	12 5 3 16	14 11 1 20	16 16 3 24	19 2 2 0	21 8 0 4	40
50	1 2 3 2	3 8 1 6	5 13 3 10	7 19 1 14	10 4 3 18	12 10 1 22	14 15 3 26	17 1 2 2	19 7 0 6	21 12 2 10	50
60	1 7 1 8	3 12 3 12	5 18 1 16	8 3 3 20	10 9 1 24	12 15 0 0	15 0 2 4	17 6 0 8	19 11 2 12	21 17 0 16	60
70	1 11 3 14	3 17 1 18	6 2 3 22	8 8 1 26	10 14 0 2	12 19 2 6	15 5 0 10	17 10 2 14	19 16 0 18	22 1 2 22	70
80	1 16 1 20	4 1 3 24	6 7 2 0	8 13 0 4	10 18 2 8	13 4 0 12	15 9 2 16	17 15 0 20	20 0 2 24	22 6 1 0	80
90	2 0 3 26	4 6 2 2	6 12 0 6	8 17 2 10	11 3 0 14	13 18 2 18	15 14 0 22	17 19 2 26	20 5 1 2	22 10 3 6	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb	t. c. q. lb.	t. c. q. lb.	Weight
	22 15 1 12	45 2 10 24	68 6 0 8	91 1 1 20	113 16 3 4	136 12 0 16	159 7 2 0	182 2 3 12	204 18 0 24	227 13 2 8	

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

ENGINEERING APPOINTMENTS OPEN.

PERSONAL NOTES.

Sir W. Guy Granet has accepted a seat on the Board of the County of London Electric Supply Company Limited.

Mr. P. F. Crinks, who for some time past has been engaged at the British Westinghouse Company's works at Trafford Park, has now returned to London, and can be found at the company's offices in Norfolk Street.

Mr. Clifford C. Paterson is terminating his appointment at the National Physical Laboratory, Teddington, and is joining the General Electric Company as director of research laboratories, as from January 1st, 1919.

Messrs. Sandycroft Limited, of 9, Queen Street Place, London, E.C., announce that their new London address is 4, Broad Street Place, London, E.C.2. Their temporary telephone number is London Wall 7144.

The London Iron and Steel Exchange Limited has appointed **Mr. Cyril Watts, F.C.A., as secretary.** He will take up his new position as soon as he is released from his duties as Assistant Controller of Aircrafts Finance of the Ministry of Munitions.

Mr. C. M. Ferguson, the well-known superheater specialist and patentee, has rejoined the staff of Messrs. James Gordon and Co., of Queen's House, Kingsway, W.C.2, in charge of their steam-power department, where he will be pleased to see any of his old friends.

Sir John A. F. Aspinall, who has been associated with the Lancashire and Yorkshire Railway Company since 1886, and has been general manager for twenty years, has asked the directors to relieve him of his responsibilities. He contemplated retirement some years ago, but consented to continue until the end of the war.

Mr. C. G. Quetton has joined the staff of Messrs. Greenly's Ltd. Mr. Quetton took his engineering degree at South Kensington, and afterwards spent six years at practical work in England and the United States. While in America his interest was attracted to the publicity side of engineering, and after some experience of the work there, he returned to England and became manager to the Sun Electric Company. Two years later he accepted a similar position with the Union Electric Company, and was holding that position when the war broke out.

The new managing director of the British Westinghouse Electric and Manufacturing Company, **Colonel Lincoln Chandler,** has resigned his position at Trafford Park owing to failing health. Colonel Chandler is a director of the Metropolitan Carriage, Wagon, and Finance Company, and he has been the representative on the British Westinghouse board of the Metropolitan and Vickers' interests. **Captain Hilton,** of the same group, has taken over the managing directorship at Trafford Park. Major Chandler, son of Colonel Lincoln Chandler, remains as the new joint secretary of the British Westinghouse Company.

Some figures recently published as to the water power of France show that 565,000 H.P. (850,000 H.P. nominal) are in employment or the necessary works are in course of construction. Of this total, 120,000 H.P. was made available in 1917, and 330,000 H.P. would be available by the end of 1918. The remainder would be available in 1920 or 1921. The development of the electrical industry has not been confined to the Alps, important works having been established in the Pyrenees. From the electrical point of view these can be divided into the following three groups: Western Pyrenees (basin of the Adour), Central Pyrenees (basin of the Garonne), and the Eastern Pyrenees (basin of the Tet). The network of the Midi Railway has been electrified between Bayonne-Tarbes-Toulouse, as well as the branch lines towards the mountains, but the service has not been opened owing to the lack of motor carriages. Especially interesting are the four installations in the high basin of the Garonne in the valleys of the Lys, of the Pique near Luchon.

GOVERNORS AND GOVERNING MECHANISM.

By A. Houlson.

(Continued from page 67.)

Part II.

We now turn our attention to the various types of automatic gears, *i.e.*, gears in which the governor controls the point of cut-off.

Piston Valve Gears.

The first case under consideration is that of the crankshaft governor operating a piston valve on a compound condensing engine of 120 H.P. using steam of 200 lb. working pressure with a superheat of 180 deg. Fah. The gear is shown in Fig. 39. The governor controls the admission of steam to the high-pressure cylinder only, varying the point of cut-off from zero to 60 per cent of the stroke. The piston valve is $3\frac{3}{4}$ in. diameter, and its travel varies from 2 in. minimum to $3\frac{1}{2}$ in. maximum.

The governor runs at 200 revolutions per minute normal speed, and has a total speed variation of 3 per cent.

The governor weights W are shown in their in-position. As the weights move outwards the plate P, and with it the eccentric sheave, are drawn across the shaft, the centre of the eccentric sheave moving from A to K. The plate P and the eccentric sheave are cast in one piece. Each governor weighs 65 lbs., and the path of its centre of gravity is shown in Fig. 39. It will be observed that the springs are arranged parallel to this path, which make for regularity. The leverage at which the centrifugal force acts, is shown also in Fig. 39 for the in-position. The leverages for the mid and out-positions are obtained similarly. The centrifugal force acts radially from the centre of the shaft and the leverage L is found by drawing a perpendicular from the fulcrum F to the line of action of the centrifugal force. The leverage I at which the spring tension acts, is found by drawing a perpendicular from the fulcrum F to the centre line of the spring.

Table 8 gives the calculations from which the sizes of springs may be obtained.

Table 8.

Position.	In.	—	Mid.	—	Out.
Revs. per minute	197	198	200	202	203
Rads. of centre of gravity, feet	·9296	·9687	1·0075	1·04	1·0833
Velocity of centre of gravity, feet per sec.	19·16	20·08	21·03	21·97	23·01
Centrifugal force, lbs. ..	797·2	840·1	886·2	936	986·6
Leverage of centrifugal force, inches	10·03	10	9·9375	9·875	9·78
Moment of centrifugal force, inch lbs	7996	8401	8806	9243	9649
Leverage of spring tension, inches	3·875	3·875	3·875	3·875	3·875
Spring tension, lbs	2063	2168	2273	2380	2490
Extension of spring, inches	3·526	3·706	3·885	4·068	4·256

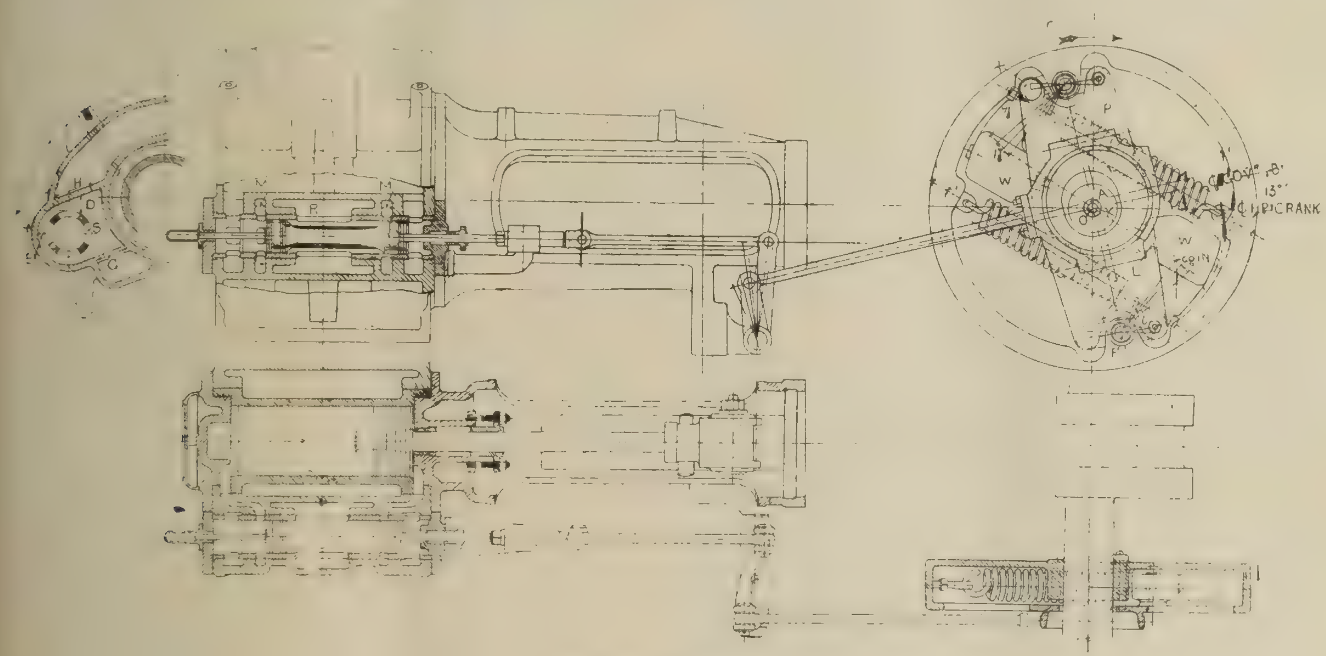


Fig. 39.—Governors

The load per inch extension of spring is =

$$\frac{\text{Spring tension at out-position} - \text{Spring tension at in-position.}}{\text{Total extension of spring.}}$$

$$\frac{2490 - 2063}{\cdot 73} = 585 \text{ lbs.}$$

The springs are $3\frac{7}{8}$ in. outside diameter of coils; 18 coils; $^{11}/_{16}$ in. diameter wire; 23 in. centres of loops when free.

The ratio of movement of the centre of gravity of the weights to the movement of the valve is 1.875 to 1.26 or 1.488 to 1. The controlling force is therefore $.02 \times 886.2 \times 1.488 \times 2 = 52$ lbs., *i.e.*, 14 lbs. per inch diameter of valve. The valve diagrams are shown in Fig. 40.

As the valve steams on the inside edges, the eccentric follows the crank, the angle between crank and eccentric being 60 deg. A line O B, Fig. 39, drawn from the centre of the shaft O tangent to the

arc in which the rocking lever end of the eccentric rod moves, makes an angle of 13 deg. with the horizontal. Therefore, in drawing the valve diagrams for maximum travels, the virtual angle of R = radius of crank; the circle E to radius = L: and F = L + R.

By assuming R = 5 units the distance $g\ h = 10$ units, then the percentages are easily measured off

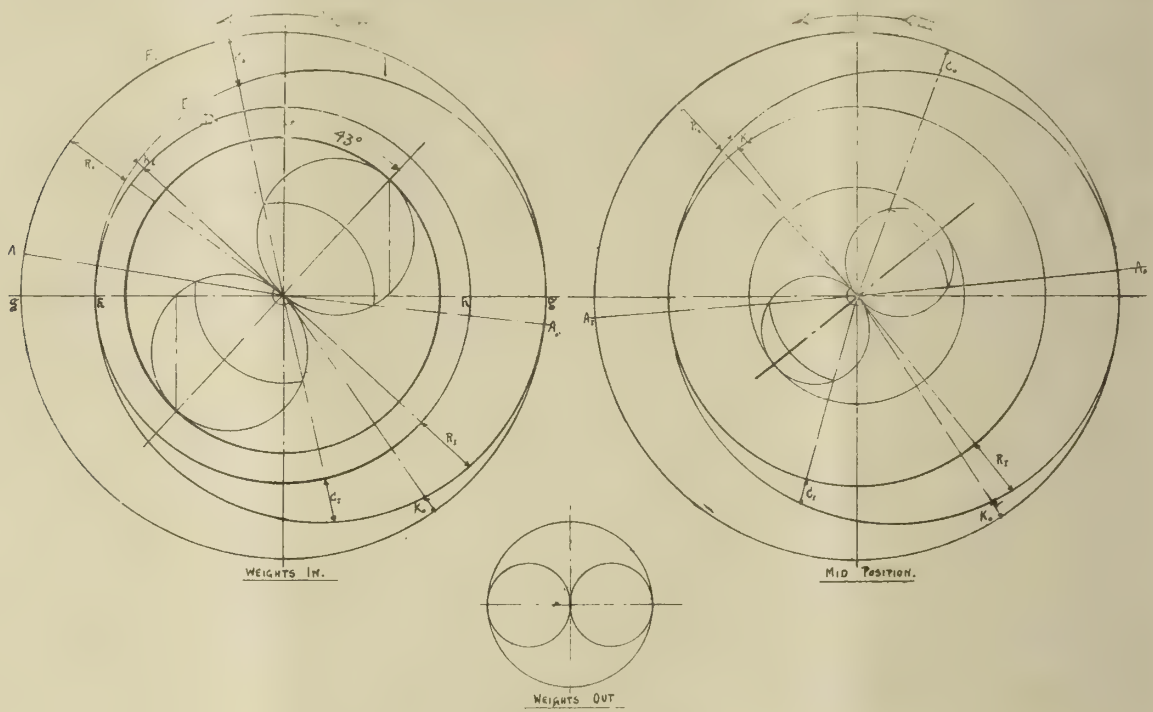


FIG. 40.—GOVERNORS.

advance is set off = 30 deg. + 13 deg. = 43 deg. as shown.

The reason for this will be made clear on reference to Fig. 41. Here OE is the eccentric driving the rocking lever, the crank being at D. The angle corresponding to the angle of advance of an eccentric driving an ordinary flat slide valve admitting steam at the outside edges may be designated the virtual angle of advance. A line OB is drawn from O tangent to the arc in which the rocking lever moves; this line makes an angle of 13 deg. with the horizontal. If OC is drawn at right-angles to OB, the angle COM = 13 deg.

by means of a decimal scale. In the diagrams, A signifies admission; C, cut-off; R, release; and K, compression; the suffixes I and O being used

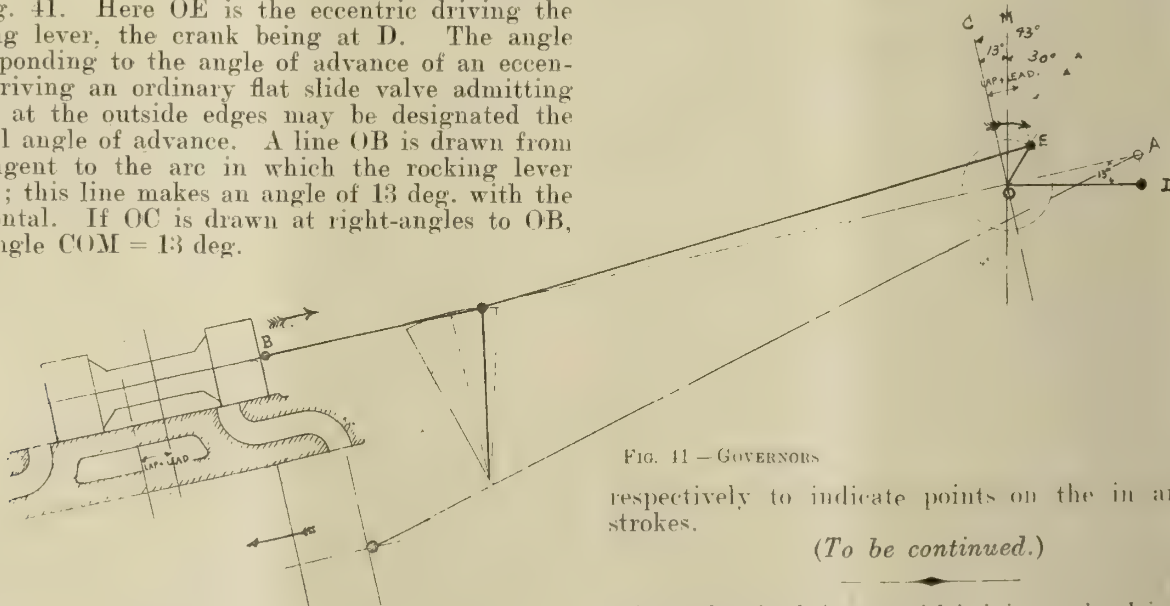


FIG. 41.—GOVERNORS.

respectively to indicate points on the in and out strokes.

(To be continued.)

Therefore, in determining the travel of the point B, the line AB may be considered as the line of centres, A being the crank at the dead point, the virtual angle of advance being COE or 43 deg.

The Muller circles D.E.F. are drawn round the valve diagram Fig. 40, the circle D having a radius = L − R where L = length of connecting rod;

A new heat-insulating material is being produced in Sweden which is stated to be very promising. The chief material is a kind of clay, "molera," which is very porous, each grain appearing to be hollow. This fact is no doubt largely responsible for its great heat-insulating properties. After it has been burnt the molera becomes extremely light. Before it is burnt it is mixed with cork. The new insulator is said to be primarily suitable for lagging steam pipes and boilers, but may also have uses for the production of sound-proof chambers and as a medium to check the transmission of vibration.

THE DESIGN AND MECHANICAL EQUIPMENT OF ELECTRIC OVERHEAD CRANES.

By H. THORNTON.

THESE articles are intended for the benefit, not of crane designers, but for those readers who are not familiar with crane practice.

There are many types of electric overhead cranes, from the small electric pulley block, which is usually slung from a travelling joist, to the large steel-works cranes, such as ladle cranes, ingot cranes, overhead crane type box-charging machines, stripper and soaking-pit cranes.

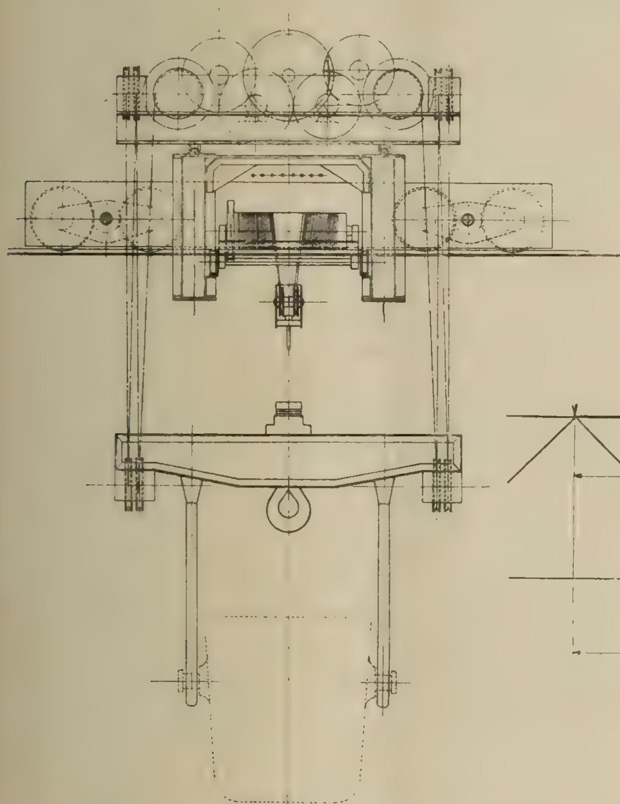


FIG. 1.—DESIGN AND EQUIPMENT OF CRANES.

The following particulars refer mainly to the ordinary 3 and 4 motor-type electric overhead cranes as found in ordinary engineering shops. There is probably a greater demand for the overhead traveller than any other type of electric crane on the market, a fact which has induced many firms to specialise in this particular branch of crane building.

Suitable Girders.

The selection of the correct type of girders for each particular crane is a very important point, as not only the general efficiency of the crane is affected by this question, but, as the girders usually represent the bulk of the crane, the success in competition largely depends upon the selection of the most economical type for the particular job. Coincident with the question of type is that of the factor of safety or the working stress. Practically all crane girders are built of steel sections made by the open-hearth acid process, and usually specified to possess a tensile strength of from 28 to 32 tons per square inch. A great variation of opinion exists on the question of working stresses, while many cranes are made having girders stressed to only three tons per square inch and even less, such as steel-works cranes. Others will be found stressed up to 7 and 8 tons per square inch; but for ordinary purposes a factor of safety of 5 is usual among the best firms, which gives approximately 5½ tons per square inch.

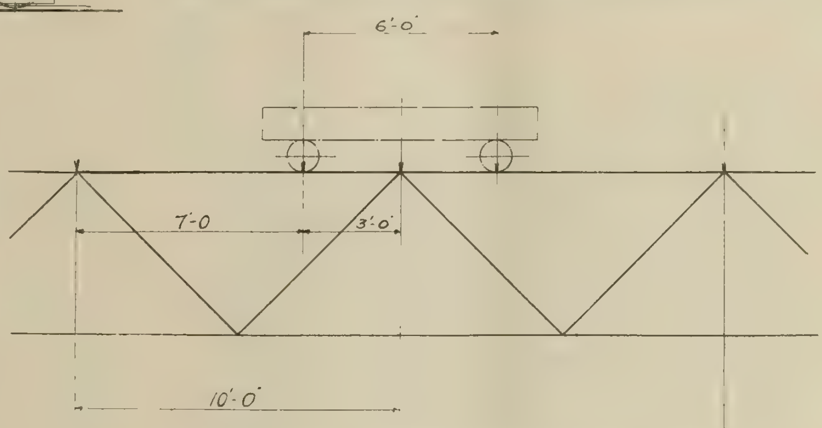


FIG. 3.—DESIGN AND EQUIPMENT OF CRANES.

Types of Girders.

There are various types of crane girders, such as the single-plate web, the double-plate web or box type, the double lattice type, single lattice or Warren type, and rolled-steel joists.

The simplest type of girder for spans up to about 40 ft. is the R.S.J., and for light loads it is undoubtedly the cheapest type, but for medium and fairly heavy loads, say from 10 to 60 tons and fairly long spans, the Warren type is to be preferred, consisting of two main and two auxiliary girders well braced together, the auxiliary girders being mainly for resisting the horizontal loads due to sudden stopping of the crane when travelling at a fairly high speed. The single-plate web type is also a very good girder, providing the flanges are made fairly

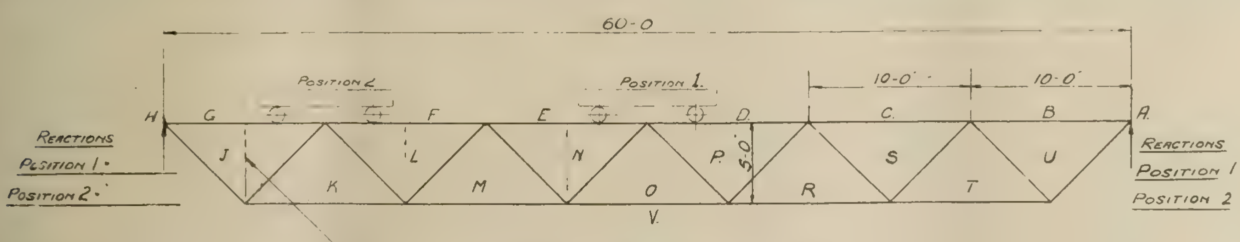


FIG. 2.—DESIGN AND EQUIPMENT OF CRANES

wide, but there is a waste of metal which is inevitable in any plate web girder. Nevertheless, they make a very strong and rigid girder, especially when fitted with braced auxiliary girders. There is also the "Linville" type of girder, or the "N" type as it is usually called, due to each bay being in the form of a letter N. This type is usually employed in conjunction with a submerged crab, that is, the crab running between the main girders on in Fig. 2, which is suitable for loads up to about 20 tons and 60 ft. span. The most economical depth of a Warren girder is about one-twelfth of the span, which, in the case of a 60 ft. span, would be 5 ft.

In the actual girder, vertical struts Z should be fixed to halve the unsupported lengths in the top boom, otherwise we should require abnormally heavy sections to resist the combined bending moment from the crab wheels and compression in the girder itself.

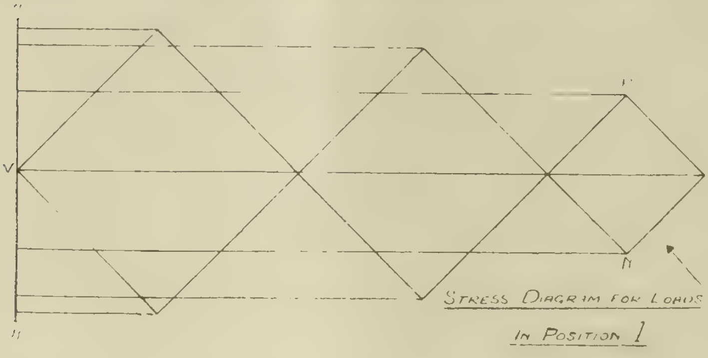
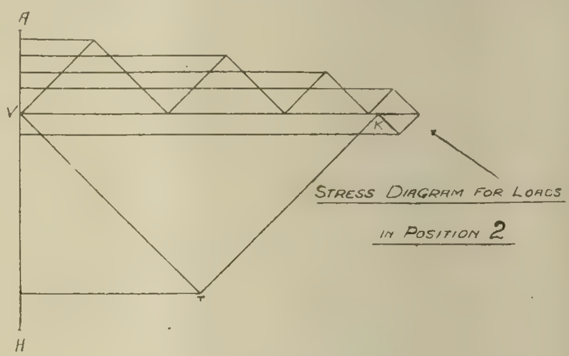


Fig. 4.



Design and Equipment of Cranes.

Fig. 5.

the bottom flanges, such as steel-works ladle cranes, the main crab running on the top of the girders, with the hoisting ropes falling outside the girders on each side, and the crab for tipping the ladle running inside the girders on the bottom flange, as in Fig. 1.

Cranes up to 75 tons' lifting capacity have been built with girders of this type, the cranes of larger capacity, up to 125 tons, being built on the box-girder principle with two sets of rails on top of each girder, to lessen the main crab-wheel loads.

In some drawing offices the stresses in the various members of lattice type girders are worked out by calculations. In other offices they are arrived at by means of stress diagrams. Some firms keep a set of stress diagram drawings in a special drawer, so that

It will be seen that the angle of the diagonals is 45 deg., which represents a good average for girders up to the size given, but in heavy cranes they are put in up to 60 deg. If lines were drawn through the centre of gravity of the various members, they should intersect at the same point, as in the case of the outline drawing from which the stress diagrams are drawn. This is necessary in order to minimise the secondary stresses which are set up, and which are of considerable importance in medium and heavy girders.

Loading of Girder.

Before the stress diagrams can be drawn the loading of the girder must be considered, and it will be necessary to assume the total weight of one girder.

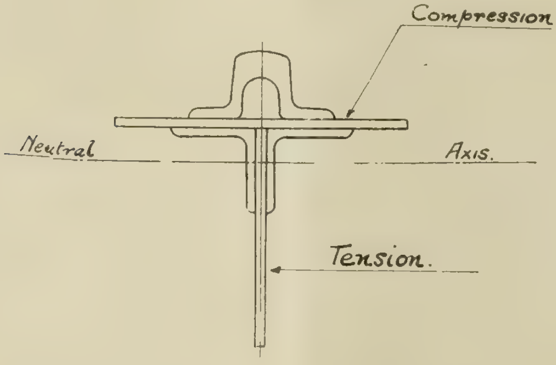


Fig. 6.—Design and Equipment of Cranes.

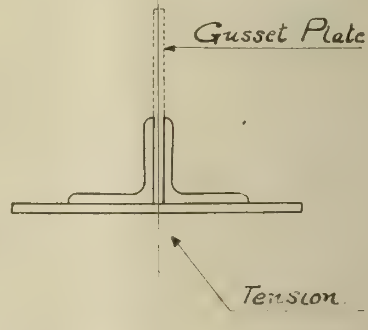


Fig. 7.—Design and Equipment of Cranes.

the loads, etc., on the various members of any girder that had been made can be ascertained.

Warren Girders.

In designing a girder of the Warren type, there are three distinct processes to be gone through. First, draw an outline of the proposed girder, fixing the depth and number of bays. Second, find the stresses which occur in each member with the load in at least two positions. Third, select suitable sections to withstand the various stresses found. A diagrammatic outline of a Warren type girder is shown

Assuming the crab wheel-base to be 6 ft., the position of the crab as shown in Fig. 3 will give the greatest reaction on any diagonals.

As previously mentioned, it is necessary to draw at least two stress diagrams, one with the crab in the centre of the span to get the maximum flange stresses, and the other over the end bay to get the maximum loads acting on the diagonals. The shape of the stress diagram with the crab in the centre of the span (Position I.) is shown in Fig. 4.

The shape of the stress diagram with the crab over the end bay (Position II.) is shown in Fig. 5.

These diagrams may be drawn for loadings over each bay in larger cranes, and the maximum force in any member recorded on another outline drawing, and the different members designed to withstand the force applied, in accordance with the accepted rules of strength of materials.

There are one or two different types of stress diagrams in use, as applied to crane girders, which are mainly used as short cuts to find the main stresses.

The top flange of the girder is, of course, in compression, and is usually composed of the rail, flange plate, two angles, and a shallow web plate as shown in Fig. 6. In designing this flange, it is necessary to know the maximum bending moment in the unsupported lengths, due to the crab-wheel loads, and in this case occurs when one wheel of the crab is in the centre of the unsupported lengths, and the compression in the *top* part of this *top* flange—*i.e.*, above the N/axis—due to the crab-wheel load, is combined with the *main* compression found in the top flange by the stress diagram, and is designed to resist this.

The bottom flange is composed of two angles and flange plate only, with short gusset plates between to take the rivetting in the diagonals, as shown in Fig. 7.

(*To be continued.*)

RAPID RECRYSTALLISATION ON NEWLY-FORMED NON-FERROUS METALS.*

By D. HANSON, M.Sc.

RECRYSTALLISATION phenomena have formed the subject of many researches. Many of these have been carried out on severely deformed material, in which the study of the effects of time and temperature of annealing have been the main objects. In the case of iron the production of extremely coarse crystals in the slightly deformed metal, after suitable annealing, has been studied by Stead, Sauveur, and others, and more particularly by Chappell. Sauveur finds that rapid recrystallisation only occurs in iron when the amount of deformation has been of a certain "critical" amount. Chappell's work does not confirm this.

Chappell shows that very coarse crystals of iron are rapidly produced on annealing deformed iron below 900 deg. Cen. provided that the amount of deformation has been small; the size of the crystals which are formed varies continuously with the deformation and is greater the smaller the amount of deformation, but the temperature at which annealing commences is higher the smaller the amount of deformation.

The only work which has been published, so far as the author is aware, on similar phenomena in non-ferrous metals and alloys, is described in a paper by Robin, but at the moment of writing a paper by R. J. Anderson, on the annealing of aluminium, is announced, in which "differential grain growth" in aluminium is described. Robin's work deals largely with the effect of time and temperature on grain size. His work on the effect of deformation prior to annealing, while it indicates clearly that the rapid production of coarse grains does occur, is not of such a character as to indicate at all clearly the relation between the amount of deformation and the recrystallisation phenomena. The manner in which deformation was produced in his experiments, by making a small indentation in a block of metal, gave a deformed region of small size, in which the transition from highly strained to unstrained material occurred over too small an area for its effect to be studied accurately.

For the following experiments a device adopted by Chappell, in his work on the recrystallisation of iron, has been used. This consists in cutting a test-piece tapered towards the centre, which, after it has been annealed, is broken in tension. In this way, with suitable tapering, varying degrees of deformation, from a maximum at the point of fracture to zero at a position between the fracture and the shoulder, are obtained. In order to obtain this, the taper must be so regulated that, under the breaking load of the test-piece, the material at the shoulder is not stressed beyond its elastic limit. The amount of taper which has proved suitable varied from metal to metal, and has been determined by trial.

Aluminium.

A tapered test-piece was cut from cold-rolled aluminium sheet 0.1 in. thick. This was then

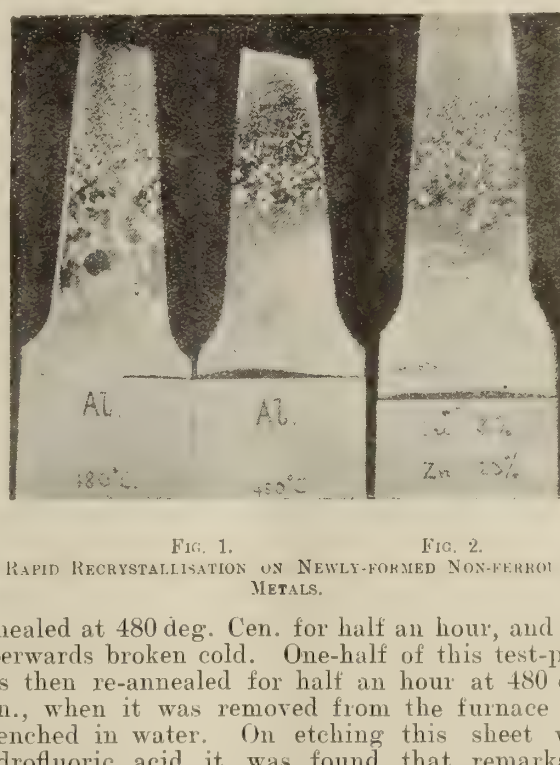


FIG. 1. FIG. 2.
RAPID RECRYSTALLISATION ON NEWLY-FORMED NON-FERROUS METALS.

annealed at 480 deg. Cen. for half an hour, and was afterwards broken cold. One-half of this test-piece was then re-annealed for half an hour at 480 deg. Cen., when it was removed from the furnace and quenched in water. On etching this sheet with hydrofluoric acid it was found that remarkably coarse crystals had developed in the neighbourhood of the shoulder where the strain was least, and that from this region the crystal size decreased fairly regularly to the point of fracture. In the material of the shoulders, which, it is assumed, had not been strained, or in which the strain had been too slight for recystallisation to take place, the original small crystallisation of the annealed test-piece was found the change from coarse to fine crystals being abrupt.

The other half of this test-piece was annealed by placing it for five minutes in a furnace at a rather lower temperature, 450 deg. Cen. In this case also

* Paper read before the Institute of Metals.

coarse crystals had developed, but for a smaller distance from the point of fracture, while the same features of a gradual increase in crystal size from the point of maximum strain towards the unstrained part are visible. This experiment indicates the great rapidity with which recrystallisation occurs, and it also suggests another important point. It will be observed on referring to Fig. 1, in which both halves of this test-piece are shown, that, in spite of the different times and temperatures of annealing, the crystal size in corresponding portions of the two halves is approximately identical, and the only noteworthy difference is that, in the specimen annealed at a higher temperature, and for a longer time, recrystallisation has proceeded for a greater distance along the specimen. When it is considered that the one specimen was placed in the furnace for only five minutes, and must have been at its maximum annealing temperature for a much shorter time than this, the rapidity with which recrystallisation has taken place is very striking.

Magnesium.

Similar experiments were carried out on pure magnesium strip 0.125 in. thick, rolled at the National Physical Laboratory, the same annealing temperatures being used as in the case of aluminium, and the same results were obtained. The actual size of the crystals produced under similar circumstances was slightly less, though not markedly so.

Zinc.

In the case of zinc, thin sheet 0.04 in. thick was first annealed at 150 deg. Cen. for half an hour, and after straining, the two halves were annealed, one at 150 deg. Cen. for half an hour, and the other at 300 deg. Cen. for five minutes. In the case of the 150 deg. Cen. annealing, recrystallisation proceeded for a distance of approximately $\frac{3}{4}$ in. from the fracture; when annealed at 300 deg. Cen. for only five minutes recrystallisation occurred right up to the shoulder, and the grain size which was developed was considerable. In this case, in which the times of annealing at high and low temperature are in the reverse order to those used for aluminium, the same observation was made that, speaking generally, crystals of approximately the same size were produced in corresponding positions in the test-pieces, *i.e.*, at positions of equal deformation. The only marked effect of an increase in annealing temperature had been to extend the range of recrystallisation towards the less deformed end of the specimen.

Lead.

The production of crystals of varying size, from small to very coarse, corresponding to varying degrees of strain, was confirmed in the case of lead, an annealing temperature of 200 deg. Cen. being used.

Copper.

Copper shows the same phenomenon. A strip of pure copper similarly treated at 800 deg. Cen. for five minutes developed new crystals measuring up to 1/10th of an inch diameter. Crystal twinning was quite well marked in this metal.

SOLID SOLUTION ALLOYS.

It was thought that this phenomenon might be less marked in solid solutions than in pure metals. Solid solutions generally appear to require a somewhat higher annealing temperature than the pure metals which they contain, and it was thought that the presence of another metal in the crystal grouping might make rapid recrystallisation, with the formation of coarse crystals, difficult.

Experiment showed that any such effect was not considerable in the case of the alloys used. These were brass and an alloy of aluminium containing 3 per cent of copper and 20 per cent of zinc.

Copper-Zinc-Aluminium Alloy.

In this alloy, which in the fully annealed state is homogeneous, but which may have contained a little undissolved $CuAl_2$, recrystallisation is not appreciably less pronounced than in pure aluminium. One-half of a test-piece, which was annealed for five minutes at 450 deg. Cen., is shown in Fig. 2. It presents exactly the same general features of a gradual increase in crystal size up to a maximum, followed by an abrupt decrease, as has been noticed in the case of pure aluminium.

(*To be continued.*)

Ball Bearings.—In reference to the following Order, made by the Minister of Munitions, namely, "The Ball Bearings Order, 1917," dated the 1st November, 1917, the Minister of Munitions hereby orders as follows: (1) The operation of the said Order is hereby suspended on and after the 7th day of January, 1919, until further notice. (2) Such suspension shall not affect the previous operation of the said Order or the validity of any action taken thereunder or the liability to any penalty or punishment in respect of any contravention or failure to comply with the said Order prior to such suspension or any proceeding or remedy in respect of such penalty or punishment. (3) This Order may be cited as "The Ball Bearings (Suspension) Order, 1919."

Electricity Supply.—In reference to the following Order made by the Minister of Munitions, namely, "The Electricity (Restriction of New Supply) Order, 1918," dated the 8th November, 1918, the Minister of Munitions hereby orders as follows: (1) As from the date hereof the said Order is hereby revoked. (2) Such revocation shall not affect the previous operation of the said Order, or the validity of any action taken thereunder, or the liability to any penalty or punishment in respect of any contravention or failure to comply with the said Order prior to such revocation or any proceeding or remedy in respect of such penalty or punishment. (3) This Order may be cited as "The Electricity (Restriction of New Supply) (Revocation) Order, 1919."

THE INSTITUTION OF MECHANICAL ENGINEERS.—A general meeting of members will be held at the Institution of Civil Engineers, Great George Street, Westminster, on Friday, January 24th, at 6 p.m. Papers will be read on "Electric Welding," by T. T. Heaton, of Uxbridge (member); "The Development of the Oxy-Acetylene Welding and Cutting Industry in the United States," by Henry Cave, of Hartford, Conn.; "Oxy-Acetylene Welding," by J. H. Davies, of the Central Technical School, Leeds; and "Oxy-Acetylene Welding," by F. Hazeldine, of the London and North-Western Railway Works, Crewe.

A NEW CHILEAN AIR SERVICE.—The first batch of British aeroplanes ceded by the Government to Chile has now reached Valparaiso. It will form the nucleus of the new Chilean Air Service, which, as a start, will consist of 14 seaplanes and 50 aeroplanes, all British machines, originally built for the British air services. Major Huston, of the British Flying Corps, is to act as chief instructor of the new force, and Engineer-Lieutenant Solano is to be the technical head of the naval section of the service. Lieut. Solano, before his new appointment, was attached to the Chilean Naval Commission in London. He studied aeronautical engineering at the Regent Street Polytechnic, London, and then became an Associate Fellow of the Aeronautical Institute of Great Britain. The first Chilean naval base will be the island of Omiriguina, almost in the middle of Talcahuano Bay.

Letters to the Editor.

The Editor will always be pleased to hear from readers who desire to express their opinions upon engineering and kindred subjects. Letters should be as brief as possible and be written upon one side of the paper only. The insertion of a letter in our columns does not necessarily mean that we endorse the opinions expressed therein.

EXCESS PROFITS AND INVENTIONS.

To the Editor of "The Industrial Engineer."

Sir.—If the industrial progress of this country is not to be utterly stultified it is absolutely necessary that some very definite pronouncement on the above subject should be made officially without delay. Put very shortly, the question which is exercising the minds of many people at the present time is this—Are profits derived from the sale or licensing of letters patent for inventions assessable for excess-profits duty or not? At first sight one would expect the answer to be a very definite negative, since the sale of a patent is surely the realisation of an asset, and should be regarded as a capital sale equally from the point of view of excess profits as it is, I believe, from the point of view of ordinary income-tax. The Finance Acts are, however, such elastic measures that the exact situation must remain uncertain until it is cleared up officially. In a specific case in which I am professionally interested I put the facts to the Commissioners, but these gentlemen, in their wisdom, decline to pass judgment on what they regard as a hypothetical case. The issue in this specific case is whether my clients shall take £50,000 from a foreign source as the purchase-price of certain foreign rights, and use it for the development of their business in this country. If the sum is to be assessable for excess profits it would be commercial lunacy for them to do so, and it will be far wiser for them to send their good British money to the foreign country for the development of their invention in that country. The result must, therefore, be that British industry will not benefit by this capital, and British industry will be retarded.

It must be remembered that companies formed to exploit inventions invariably include in their professed operations the acquisition of the foreign rights with a view to their resale at a profit when opportunity offers, and if the Commissioners are going to claim that sums derived from these sales are assessable for excess profits on the ground that they are profits arising out of their "trade or business"—and there are indications that they do intend to do so—there can be no doubt that great damage will be done to the industrial development of this country, which depends more upon inventive progress than upon anything else. I regard this question as of such great national importance that I propose to raise it formally at the next meeting of the Chartered Institute of Patent Agents, and I am also making arrangements to get it similarly discussed by the Institutions of Civil and Mechanical Engineers, and other learned societies, in the hope that some concerted action may be taken which will result, at any rate, in the subject receiving the attention its importance merits. I shall be grateful for all the assistance I can get, and shall be glad to hear from persons affected, particularly where they can give me specific examples to show the seriousness of the whole subject as affecting national progress.

A. A. Thornton, Fel.C.I.P.A.

6, Quality Court, London, W.C.2.

Reviews.

MODERN STEAM BOILERS: THEIR CONSTRUCTION, MANAGEMENT AND USE. Scott, Greenwood and Son, 8, Broadway, Ludgate, London, E.C. Price, 12s. 6d.

This book consists of 275 pages, with 105 illustrations, five plates, and 33 tables. It is divided into 11 chapters, which include a chapter on temperature and heat, one on steam generation, one on fuel combustion, and other chapters dealing with boiler materials, boiler construction, vertical and water tube boilers, Lancashire and other types of boilers, boiler fittings, boiler feed water and boiler draft, with a final chapter on the management of steam boilers. The letterpress is clear, many of the illustrations are good, and the plates are well-reproduced. For the size and price of the book it is profusely illustrated, and in a technical work this is of the first importance. It is better, however, to have fewer illustrations, and have them as good as they can be made, than to have a larger number not of the best quality, with, occasionally, some not worth reproducing, such as that on page 132. It must be remembered, however, that illustrations are costly, and what can be done in this direction is limited by the price at which a book must be sold to obtain a circulation.

The author of the book, as will be seen from the titles of the chapters given above, attempts a very great deal within a small compass. It must be said that he has succeeded to an admirable degree in giving, in a compact and lucid manner, much useful information on steam boilers and the conditions of their working. This is a great merit in any book. There are no complex formulas given. For a technical work, it comes as near as can be, if not to the point where he who runs may read, yet certainly to the point where he who walks may read. The technical student, the engineer in charge of boilers and engines, the intelligent stoker, engineers generally interested in steam boilers, and works managers will find this a very useful work to have on their shelves.

It would be a good thing if millowners and works managers would make a practice of encouraging their engineering staffs engaged in the running of mills or works in the perusal of sound technical works by presenting copies to those likely to make use of them. As technical works, in the nature of things, must be somewhat expensive, owing to the cost of production, help is necessary to place these works in suitable hands.

The necessity for working power plants on the most economical lines is becoming more and more obvious. It is certain that the price of fuel will never drop again to the old levels. Particulars of numerous tests made of all kinds of power plants show that generally speaking very many are working from 10 to 20 per cent below their maximum possible efficiency. Elimination of waste in the production and use of steam is, therefore, both of importance to steam users and to the nation. In some cases the fault lies not in the management of the plant, though there are few plants where some improvement cannot be effected, so much as in the fact that the boilers and engines are overworked, and overworked plants cannot be economical. It is also overworked plants which are the worst sinners in the production of smoke, so detrimental to the health and of those of us who dwell in the industrial regions. By way of relief to what has just been said, it should be added that the steam-power production and use in many of the modern cotton mills of Lancashire is, if not perfect, about the most economical in the world.

The author gives a large number of illustrations of modern types of boilers, both of land and marine types. The extensive use of water-tube boilers in electrical power stations on land and in various types of warships at sea, has resulted in the development of a considerable number of types. In due course, it will be very interesting to learn how the various types of water-tube boilers have behaved in the war-ships. In the Allied Navies we have a large number of types of water-tube boilers, and as the Allied Navies have done such a large amount of cruising in the 4½ years of war, some interesting results as to wear and tear and safety may be expected. In our own Navy, the Yarrow and the Babcock marine types of boilers are the types which predominate.

For mill work the Lancashire boiler has become the standard type, and the tendency in the design of this type of boiler has been towards greater simplicity in form. It has been found in practice that the multiplication of tubes and pockets in the furnace tubes of Lancashire boilers has been disadvantageous, and especially so in districts where the boiler feed water is sedimentary. This leads us to say that more attention needs to be paid in future by boiler owners to the purification of boiler feed water which enters the boiler. To use steam boilers as mud collectors is putting them to unprofitable use. The Galloway type of boiler, with its kidney-shape flue full of cross-tubes, has to some extent been the rival of the Lancashire boiler. As between a clean Lancashire and a clean Galloway boiler, the economical advantage is slightly in favour of the Galloway boiler. Sedimentary feed water and sooty fuel, however, nullifies the advantage, and scaly feed water makes cleaning more difficult owing to cross-tubes. The dish-ended Lancashire boiler without cross-tubes in the flue tubes brings the Lancashire boiler to its greatest possible simplicity by doing away with gusset stays, though this is not always an advantage.

The present tendency as regards steam boilers is towards considerably higher pressure, and to highly superheated steam. In mill work the standard steam pressure of Lancashire boilers is 160 or 180 lb., and occasionally 200 lb. pressure per square inch; the degree of superheating is about 90 to 100 deg. Fah. The Lancashire boiler does not lend itself constructively in the

sizes at present in use, that is to say, 8 ft. and 8 ft. 6 in. in diameter, to much higher pressures than 200 lb., though it is quite possible to make them for pressures of 250 lb. In an electric power station there is already a plant of water-tube boilers successfully working at 275 lb. per square inch, with 200 deg. of superheat, and plants are projected where the pressures will be 300 lb. to 350 lb., and in one case the writer is in intimate touch with a plant of ten boilers whose working pressure will be about 460 lb., and the blowing-off pressure 475 lb., while the superheat will be 200 deg. If these plants are economically successful to the degree hoped for it may mean that it will be possible to supply electric power at a price which will not pay the individual millowner to have his own power plant, or it may be found economical in the case of large firms, or a closely-grouped combination of firms, to have a common boiler-house, with boilers working at high temperatures and pressures in conjunction with steam turbine and electrical generating sets. They will then only require their own steam boilers, either singly or in combination, for their heating or manufacturing purposes. Where no steam is required for manufacturing purposes, heating by hot water is found the most useful medium of heating for keeping workshops and offices in the most comfortable condition for the workers.

We miss from this work any chapter dealing with pumps and injectors, and we find no chapter on the various forms of mechanical stokers now so extensively used. These, however, are not within the professed scope of the book. There is also no chapter illustrating the types of steam boilers now so extensively used in steam wagons and tractors, of which there are now very many thousands at work in this country. Their number is likely to be very largely increased after the war. The steam wagon is still the most economical means of transport as regards fuel, and perhaps the most reliable. These omissions from the book are not mentioned as detracting in any way from the value of the book. Where so much is given for the money, it would show an ill mind to growl that there is not more. The subjects treated in the book are numerous enough to provide half a dozen text-books of similar size.

We should not expect in a work of this kind that it would be faultless. On page 80, for example, under the heading, "Joints," it is said that the most approved method is flanging the endplate. This is true of water-tube and vertical boilers, but not of Lancashire boilers. Lancashire boilers have their front ends attached by means of an external angle, as shown on Fig. 60 of the same page, and as shown in the various illustrations. The method shown of attaching an endplate in Fig. 59 is now obsolete, and this should be omitted in future editions. Fig. 63, on page 81, is a method of connecting parallel plates together which the writer has never met with in his experience of steam boilers. It would be an improvement if, in a future edition, on page 83, the importance of only having the slightest possible clearance at the spigots of mudhole covers were emphasised, as many lives have been lost by packings being blown out under steam from the spigot clearances being too wide.

The brief paragraph respecting welded joints at the beginning of page 81 requires amplifying and qualifying. It is said "welded joints are stronger than riveted ones, and are nearly the strength of the plate itself, and at the same time the plate is not strained as it is in the lap joint." This is misleading. Smith fire-welding has been extensively used for a great many years in the construction of the parts of boilers under compression stresses, as in the case of internal furnaces and flue tubes, but, except for low-pressure boilers or parts of boilers of small diameter, welding has not been used in the construction of the shells of boilers. Great progress has been made in welding of recent years, by the use of acetylene gas and electricity, by which welds can be made with great facility. With welding, however, much lies in the skill of the operator, and the conditions under which the weld is made. There are also no means of ascertaining the strength of a weld for the purposes of calculation, as there is in the case of a riveted joint; and although a good weld may approach very nearly the strength of the solid plate, it is the practice to take only 50 per cent of the solid plate as the strength calculation for such a joint. On the other hand, a riveted joint may be equal to 84 per cent of the solid plate, and the strength as calculated is allowed in fixing the permissible pressure of a boiler shell. Owing, therefore, to a measure of uncertainty attending welded joints, these joints are not permitted for the shells of high-pressure boilers, nor are they likely to be permitted by any standard authority. There is, however, in other directions a wide and increasing field for welding, both in repairs and construction.

Publications.

Many difficulties in the hardening and tempering of steel articles are chiefly brought about by human error, and to those whose business is connected with this operation a booklet regarding the "Wild-Barfield" Patent Electric Furnace, manufactured by the **Automatic and Electric Furnace Co. Ltd.,** 6, Old Queen Street, London, S.W., will be of special interest. The construction of this apparatus is extremely novel, and comprises an inner pot of highly-refractory material, containing a special mixture of salts, and an outer cylinder, from which it is insulated by suitable lagging. The inner pot is wound with a heating element (which also serves as a magnetising coil) having a regulating resistance, and connected through a double-pole switch and fuses to the supply mains, and round the outer cylinder is wound a coil of wire connected to a specially constructed galvanometer, complete with scale, condenser, and lamps. The principle worked upon is that at the point of decalescence carbon-steel loses its magnetic properties, and it is then at its best temperature for quenching. The loss of magnetism is immediately indicated by the action of the galvanometer. It is stated that amongst other advantages this process offers are that the critical point is both accurately and automatically determined, human error being therefore entirely eliminated; consequently the work can be left in inexperienced hands, the amount of distortion is reduced to a minimum, amounting to generally not more than .0001 in. Some of the applications for which this furnace is adapted are the treatment of screw, cylindrical, and plate gauges, press and cutting tools, and the experimental determination of decalescent temperatures in the laboratory. A quenching bath is made, similarly heated; it is not considered, however, an essential part of the equipment, but will be made to order. There is, not the slightest doubt, great possibilities for the "W.-B." Furnace, and although it has only recently been introduced, it is stated that plants have been installed in a large number of works, producing results never previously obtained. Figures regarding tests of samples carried out at the National Physical Laboratory amply justify this assertion. Furnaces are made in various sizes to take material up to 12 in. in length, the current consumption being remarkably small (4,200 watts). We are informed that the Company will be pleased to demonstrate the operation of this process to those interested.

That well-known firm of crane makers, Messrs. Thomas Smith and Sons, of Rodley, having been recently converted into a private limited company, is now known as **Messrs. Thomas Smith and Sons Ltd. (Rodley), Leeds,** the personnel, however, remaining the same. Amongst the various types of cranes manufactured we may mention locomotive (steam, electric, shunting, and breakdown); overhead travellers (electric, power and hand); gantry, Goliath, foundry, travelling, and pillar cranes, besides special cranes designed for a particular purpose. Their catalogue No. 620 is profusely illustrated, containing particulars of construction, etc., notable features amongst which are a description of a steam overhead traveller, for use where electricity is not available, or where steam is favoured as a means of power, and an electric tractor for hauling trucks into a suitable place for unloading, being controlled from an independent cabin a short distance away. Steel grabs and buckets are illustrated, also steel ropes and chains, details as to weights and breaking strains being given. The firm was founded in 1820, possess a works covering 15 acres, and have a wide reputation as makers of cranes and appertaining apparatus.

Queries and Replies.

We shall at all times be pleased to help our readers out of their difficulties to the best of our power, and invite them to make use of this column for that purpose.

J. N. (Trafford Park).—To meet such a case as yours, we have arranged to publish a series of articles entitled "Worked Examples in Applied Mathematics," the first instalment of which will appear in our issue for Feb. 8th.

A. H. (Leeds).—A good bronze paint for iron may be made in the following manner: Take 1 oz. of ivory black, 1 oz. of chrome yellow, 2 lb. of chrome green, and mix with raw linseed oil, adding a little japan to dry it.

C. R. (Longton).—No examinations are necessary for the appointments you mention, and vacancies are usually advertised in the daily papers.

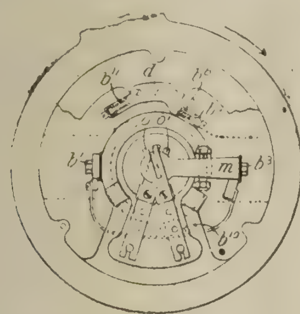
Patent Applications.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

ABSTRACTS OF SPECIFICATIONS.

DYNAMO-ELECTRIC GENERATORS.

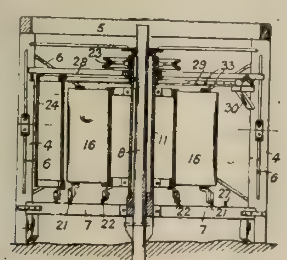
118,886.—J. STONE & CO., Deptford, Kent, and A. H. DARKER, Langham Hotel, Portland Place, London.—Sept. 13th, 1917.—Relates to reversible dynamo-electric machines, and particularly to the dynamos of railway trains, etc., provided with radial conductors *m* for conveying the current from the main brushes *b*1, *b*3 to central contacts *o*, *o*1 as described in Specification 114,021, and



comprises the combination therewith, in self-regulating dynamos wherein the field winding is connected to subsidiary brushes, of contacts *b*8, *b*10 upon the subsidiary brushes which are adapted to make connection with fixed contacts *b*9, *b*11 in the two extreme positions of the brush rocker *d*. The contact *b*11 is placed farther from the centre than the contact *b*9 to allow the passage by them of the contacts *b*8, b10 respectively when the dynamo is reversed.

CURRENT MOTORS.

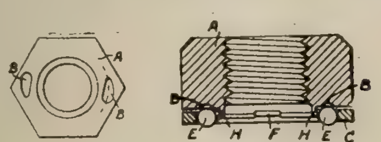
118,899.—A. L. MUNN, Merimbula, New South Wales, Australia.—Sept. 20th, 1917.—The rotor blades 16 are fixed to a sleeve 11 rotatable about a fixed shaft 8, and are partly supported by rollers running on circular rails 21, 22. A rope pulley 23 is also fixed to the sleeve 11. A deflector plate 24 is partly supported on rails 27 and partly on a beam 28, by means of which it may be rotated and set in any required position. The beam 28 is supported on a rail 29 and may be locked by a latch 33. A curved plate sliding



on the deflector plate 24 may be provided to mask the vanes of the motor. The whole motor is supported on a framed and braced structure placed on a foundation in the bed of the stream or other suitable place. This frame includes vertical posts 4, a rectangular upper frame 5, a pair of diagonal members 7, and bracings 6. The rails 21, 22, 27 are carried by the members 7, and the rail 29 by brackets 30 fixed on the posts 4. For tidal waters, the frame and the motor may be arranged for vertical adjustment.

LOCKING NUTS.

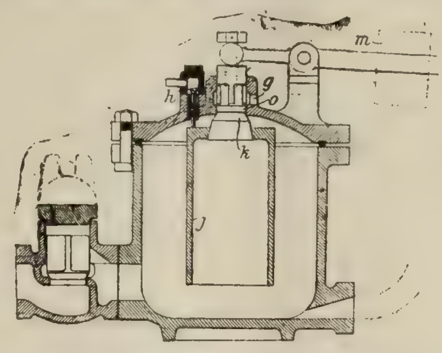
118,965.—W. G. KENT and B. C. CURLING, 199, High Holborn, London.—Dec. 21st, 1917.—A nut A is locked by balls E carried in a washer C arranged between the nut and the work and engaging



tapered slots B in the nut. The washer is provided with projections F to limit the relative motion between the washer and nut to ensure the engagement of the balls with the slots. The nut is provided with a flange H to retain the washer in position.

RAISING LIQUIDS.

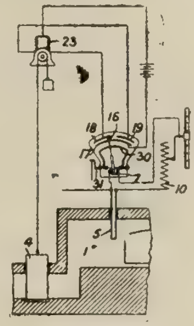
118,901.—J. E. L. OGDEN, Penshurst, Lincoln Drive, Liscard, Cheshire.—Sept. 22nd, 1917.—Apparatus for raising liquids comprises a float *j*, which may be bell-shaped and is attached to a



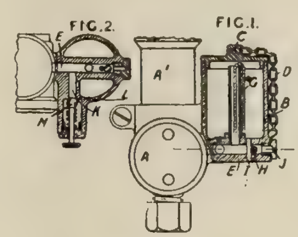
valve *k* controlling the atmospheric port *g*. The float, on rising, closes the outlet valve and opens the air-inlet valve *h*. The valve *k* has a piston portion *o* to cut off the chamber *a* from the atmosphere before the valve seats . The valve *k* and float may be counterbalanced by a weight, etc., *m*.

THERMOSTATS.

118,922.—F. J. BROUGHAM, 10, New Court, Lincoln's Inn, London.—(Saurer, A. [Firm of], Arbon, Switzerland.)—Oct. 12th, 1917.—In apparatus for operating the damper 4 of a furnace 1 by a high-tension motor 23 under the control of a thermo-electric element 5 in the furnace, the movable contact 16 of a switch placed in the motor circuit is operated by the low-tension current of the thermal element and is supported at a distance from the fixed contacts 17, 18, 19, being pressed down upon the fixed contacts at predetermined intervals by clock-work or other mechanism. The movable contact is rotated in the manner of a galvanometer needle by a coil 7 in the circuit of the thermal element. An adjustable resistance 10 is provided in the circuit for regulating the operation of the switch. The movable contact is pressed down by a bridge-piece 30 on an axle 31 connected to the clock-work mechanism.



Patent 118,922.



Patent 118,937

LUBRICATORS.

118,937.—K. ROTHERHAM, 27, Spon Street, and W. JOHNSON, 39, Park Road, both in Coventry.—Nov. 10th, 1917.—In an air pump, lubricating-oil is fed by means such as a wick to a conduit connecting the closed crank casing with the atmosphere and provided with a non-return valve to admit air at the end of the conduit; an additional oil supply branch is provided. As shown, oil is fed by a wick G, Fig. 1, from a chamber B, provided with a screwed lid C and a retaining-chain D, to a conduit E leading from the atmosphere to the closed crank casing A of a pump A1, and a atmosphere to the closed crank casing A of a pump A1, and a ball valve H with a seating J and a retaining-pin I is provided in the conduit to admit air to the casing A during the suction stroke of the pump plunger, the air carrying the oil from the wick into the casing. Initial or additional oil is supplied from the chamber B through a duct L, Fig. 2, and a passage K to the conduit E when a spring-pressed valve M is opened by hand The air pumps may be used in the fuel feed systems of aviation engines.

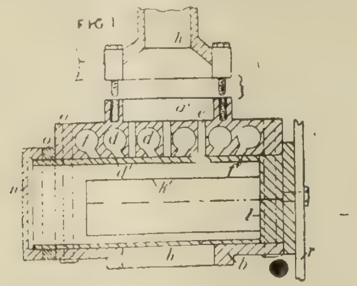
INTERNAL-COMBUSTION ENGINES.

118,934.—W. J. WALKER, 18, Savernake Road, Hampstead, London.—Nov. 5th, 1917.—In a cycle in which the methods of working at constant pressure and constant volume are combined, the compression pressures are reduced, as compared with those in common use in Diesel cycles, by delaying the commencement of compression until the piston has completed a portion of its stroke. Specification 114,065 is referred to.

INTERNAL-COMBUSTION ENGINES.

118,944.—B. W. SYKES, Knapton Lane, Acomb, York.—Nov. 17th, 1917.—Apparatus for carburetting air with gaseous or liquid fuel comprises a rectangular casing made in halves *a*, *b* which, when bolted together, enclose a rotatable throttle valve *k* having two oppositely arranged ports such as *k*1. The upper half *a* of the casing has transverse main and auxiliary air passages *d*, *f* respectively, the outlets *d*1, *f*1 from which are inclined to passages *e* which receive gas from the gas chest *a*1 to which the gas supply

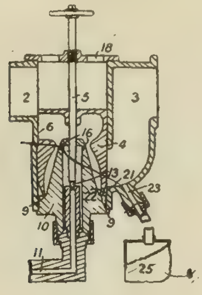
pipe *h*, which may have a non-return to prevent back-firing, is bolted. The supply of auxiliary air is varied by fitting removable caps to the ends of the passages *f*. The throttle valve, which is actuated by the arm *r*, is solid at one end *l*, but the other end



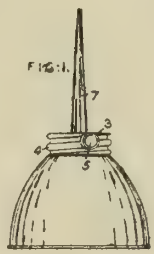
is open and is provided with an adjustable cap *n* and lock-nut *o*. The apparatus may be used with liquid fuel by inverting it, supplying the liquid to the pipe *h*, and reducing the size of the passages *e*.

INTERNAL-COMBUSTION ENGINES.

118,946.—F. G. INGLIS, 23, Clairville Road, Middlesbrough, Yorkshire.—Nov. 20th, 1917.—Air enters a spray carburettor at 2, passes downwardly through a movable valve 4 and over a conical nozzle 10, and the mixture escapes at 3. The valve 4 has a lateral inlet aperture 6, or it may have apertures in its upper end and its interior surface is so shaped as to provide, during its adjustment, a varying passage or choke adjacent the fuel delivery orifices 16. The fuel is supplied through a pipe 11 from a float chamber, which maintains the level just below the orifices 16, and the quantity flowing is regulated by a needle valve 13, screwed through the cover 18 and the spindle 5, of which serves as a guide for the valve 4. The lower end of the valve 4, in its closed position, rests on a seating 9 formed in a well 21 in which fuel may be made to collect and from which it is drawn to the engine at starting, together with air admitted through holes 22. A drain 23 discharges into a sealed tank 25, which may be formed integral with the carburettor. An extra air valve may be fitted between the valve 4 and the carburettor casing and the valve 4 may be made in two parts, the lower or shaped part being interchangeable to suit engines and fuels of various types.



Patent 118,946.



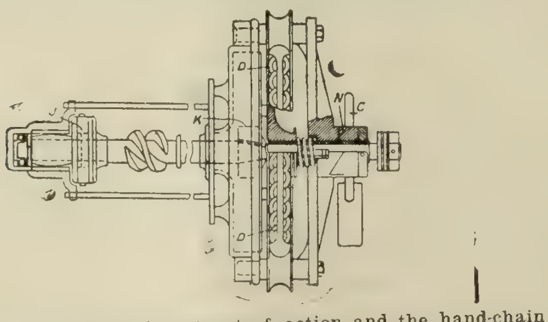
Patent 118,953.

LUBRICATING-CANS.

118,953.—J. W. SUTCLIFFE, Atlas Works, Horsforth, near Leeds.—Nov. 30th, 1917.—In a metal lubricating-can having a screwed-on cover 3 formed with a nozzle 7, the flange 4 of the cover is provided with one or more projections 5 arranged to facilitate removal of the cover.

HOISTING APPARATUS.

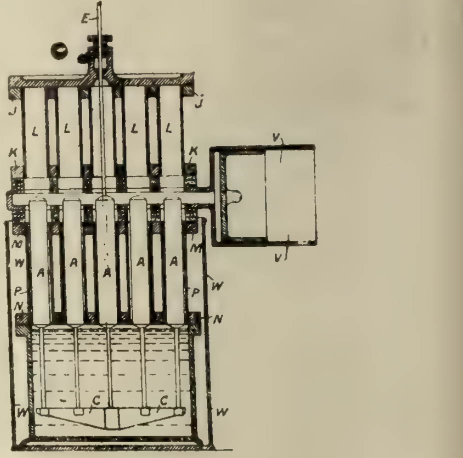
118,975.—P. GROUNDS, 2, Cyrus Street, Holt Town, and T. J. SHAW, 70, Redvers Street, Ardwick, both in Manchester.—Feb. 1st, 1918.—In pulley block hoists driven through worm gearing and provided with axial pressure self-sustaining gear J and a brake K,



the self-sustaining gear is put out of action and the hand-chain wheel D declutched from the worm shaft by moving the chain wheel away from the brake K by means of a cam N connected to the control lever C. The wheel D is retained in this position by a catch which is freed when the wheel is partially rotated, and the wheel is then returned to engage the worm shaft by a spring.

HOT-AIR ENGINES.

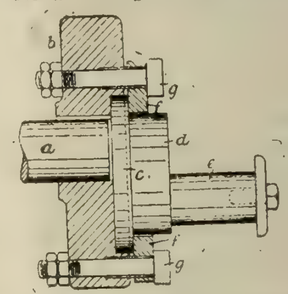
118,958.—W. J. POOLE, Westercraigs, Craigendoran Avenue, Craigendoran, Dumbartonshire.—Dec. 5th, 1917.—Displacers A work in tubular chambers L, P mounted in tube plates J. K, M, N. The chambers L are surrounded by furnace gases which also circulate around the power cylinder V, the chambers P are immersed in a



vessel of water W. The chambers are insulated from each other and from the cylinder. The displacers are driven by a rod E through a cross-head C immersed in water. The cylinder V may be situated above the chamber L. The displacers and their chambers may be circular, fluted, or stellate in cross-section.

ADJUSTABLE-THROW CRANKS.

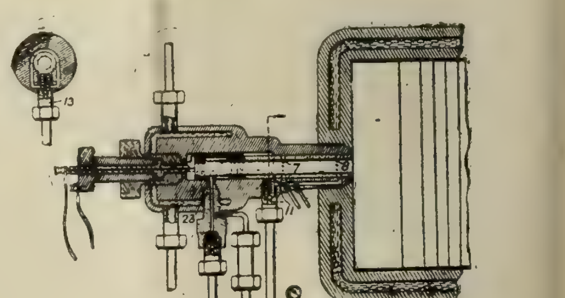
118,959.—W. GREEN & CO., Norfolk Foundry, Ecclesfield, and J. WORSTENHOLM, 591, Abbeydale Road, both in Sheffield.—Dec. 6th, 1917.—A crank-pin *e* for actuating the connecting-rod of a power



hammer, or slotting or other machine, is mounted on an eccentric *c*, *d*, which fits a circular eccentric recess in a disc *b* secured to the driving shaft *a*. The disc *c*, *d* is set in position to give the desired throw and clamped in place by a ring *f* and bolts *g*.

INTERNAL-COMBUSTION ENGINES.

118,990.—L. BARTLETT and P. S. BAKER, 703, Market Street, San Francisco, U.S.A.—March 11th, 1918.—A charge of heavy fuel is injected through a pipe 13 into a chamber 16 partly surrounding a tube 6 which is heated by electricity. A light fuel, mixed with water if necessary, is injected into the tube 6 through a nozzle 23 at the end of the compression stroke and, becoming vaporised



and ignited, expels the heavier fuel from the chamber 16 through the passage 11 and either the ports 7 or the ports 8 into the tube 6, where it also becomes ignited by the flame of the lighter fuel. The chamber 16 is water jacketed. The apparatus may be used for injecting fuel into a charge of gas and air in the cylinder. The lighter charge may be used to spray water into the cylinder instead of heavy fuel.

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EDITORIAL.

A LEAGUE OF INDUSTRIES.

No industrial engineer can afford to view the present unrest in industry either with indifference or passion. Both are bad influences if one wishes to arrive at any satisfactory arrangement for the future as between Capital and Labour. Whatever be the views or feelings to-day of those on the managerial side, in factory or works administration, to-morrow they may be caught up in one or other of the formidable mass movements which are sweeping, not this country alone, but the entire civilized globe. To-day, in a particular industry, we may have no urgent labour problem, but that is no reason why the question should be dismissed from our minds as something that does not concern the industrial engineers, either directly or indirectly. How quickly the trouble spreads may be judged by a survey of recent events, and if that survey is made in a broad-minded spirit, and one of sympathetic understanding, a great deal more may be learned from it than at first sight seemed possible or probable.

What is Manual Labour's Point of View ?

Amidst all the railing and bitter speech which one hears uttered against the British working man one fails to find any true perception of his point of view. That he has got one there is little doubt. But he is very largely the victim of vicious circumstances which have, to a large extent, coloured his outlook. He has, for example, been left to pick up his political economy in a bitter school, and small blame to him if it has been coloured with much prejudice and bitterness. He has been alternately threatened and cajoled like a spoilt child, his mentors being, in the main, those who were after his vote for their own particular and personal ends—ends, indeed, which were by no means always identical with his. His self-education in economic matters has grounded him in the belief that capital is altogether in the hands of a few multi-millionaires, whereas a very large proportion of it is held by thousands of individuals—widows, infirm and elderly persons—and the income from which constitutes their entire bulwark against penury. In all their negotiations has this side of the problem been given ten minutes' careful consideration by them, or have they been reminded by those who are managing industry on behalf of capital that much of the money invested is the savings of hard-working and thrifty people who have not had the economic advantages of the strike weapon? It would seem to us that our British workmen, who cannot be accused of possessing a double-dose of original sin, owe their present education—faulty and full of unfairness as it obviously is—to those who are now complaining loudest as to its outcome. Such a state of affairs is not, of course, new, and it is precisely for that reason that we urge a fuller and less one-sided consideration of the relations between capital and labour than we appear to have attempted hitherto.

Our Administrators and Industrial Councils.

A great deal was made of the possibilities of the Industrial Councils that were to be established in accordance with the recommendations contained in the Whitley Report. They promised a continuous and conjoint study of the problems dividing the two great belligerents in the industrial conflict, but no sooner does the shadow of the Great War begin to

fade than the industrial menace flashes up greater than ever; this, in spite of that new spirit of comradeship which, we were so often told, was going to assist in healing old wounds. In our opinion, much of the blame must lie with our Administration, past and present, who have either stood aloof, like a neutral, obsessed with the idea, or apparently so, that industrial troubles were no affair of theirs, or who have capitulated to the noisiest or most numerical faction. Again and again, we have seen it give in without a struggle, a particularly flagrant surrender being on the question of coal prices, when one would have thought that the interests of the consumers of this vital commodity would have been maintained to the last. It is in ways like this that the workers get the idea that whatever their demands, the master will grant them because the latter will pass the extra cost on to be paid by the consumer. That is the argument, and we are afraid that only too often has it been the practice. The Government, when it should have strongly defended the interests of the consumers, abdicated its functions and the strife everywhere visible around us is a direct consequence.

Where all this will end it is difficult to foresee, but no one who wishes his country well in all her legitimate pursuits, can look on the present trend of events with satisfaction.

What Alternative is there?

Many anxious minds are no doubt giving their thoughts to finding an answer to this question, and we need not, therefore, offer any apology for suggesting a line of thought that comes to us from the great Peace Conference now sitting in Paris to settle problems of world difficulty. The members of that assembly have realised that if the settlement they arrive at is to have a lasting influence for good it must carry within its scope the framework of an organisation which shall survive and function when the necessity for it arrives. Despite the setting up of a distinctly Labour Ministry, our State machinery seems to be much too unresponsive to the approach of industrial trouble. What we require is an industrial league on the lines of the proposed League of Nations, so far as we understand them. In the first place, such a body as we have in mind would represent the State, the employers, and the employees. In the next place, it would meet at regular intervals to consider questions which had arisen or were about to arise in any of the industries under its control. It should be laid down as a settled law that neither a strike nor a lockout could be sprung on an industry and the country without adequate warning, so that opportunities might be given for a thorough consideration of the matters in dispute. It is well-known that there are agitators, as there have been rulers, interested in precipitating a crisis before either party has had time to consider the alleged causes or the outcome. That is what we have got to secure in the industrial domain as a beginning.

Guarantees for Performance.

The feature of such a league which would be likely to present the most difficulty is that of guarantees as to the due performance of any decision arrived at by the league as a whole. It might be argued that behind this organisation would stand all the power of the State to enforce any agreement which one of the other parties might be disposed to challenge or fail to keep. We have, however, had the unpleasant spectacle of industrial agreements being repudiated, not perhaps by the actual signatories, but by sections of those whom they were supposed to represent. There must be material guarantees, and we cannot conceive anything more practical than the obligation on the trade unions on the one hand, and the employers' federations on the other, of depositing to the credit of the league as a whole a specific portion of their funds, which would be profitable in the event of a breach of agreement. The prospect of forfeiting large sums might not act as a complete deterrent, but it is clear that the economic weapon is a much more formidable one than any other at present within the region of practical politics. This analogy we surely have from the proposed League of Nations, wherein the policy of applying an economic boycott to any recalcitrant member appears to find general approval as a substitute for force. Briefly, we want a scheme that will ensure that adequate time for negotiations shall be allowed in which to find a settlement before a strike or lockout is entered upon; that in all troubles of this nature the State shall be directly represented to safeguard the interests of the community as a whole; and a practical form of guarantee that all agreements entered into shall be observed.

MODERN STEAM TURBINES.

By J. Humphrey.

(Continued from page 131.)

Back-Pressure and Reducing Turbines.

Back-pressure and reducing turbines are highly suitable for use in places where steam at a pressure, which cannot be described as either boiler or exhaust pressure, is used for some manufacturing process, and where, at the same time, electrical energy is required. It is common knowledge that boilers are most economical when worked at high pressures, and, consequently, if steam is required at, say, 20 lb. pressure, it is far more economical to take such steam from the exhaust of a steam turbine than to take it direct from low-pressure boilers. If electrical energy is needed, in addition to low-pressure steam, the best policy is to instal high-pressure boilers, working at, say, 200 lb. per square in., and to couple a turbine, designed for the same initial pressure, to them. The energy in the steam between the pressures of 200 lb. and 20 lb. (assuming a supply of steam at the latter pressure be needed) would then be converted into electrical energy by the turbine, whilst the exhaust steam would be available for the manufacturing processes. Similarly, in hospitals and other public institutions, where steam is required for heating, and electricity for lighting, the same practice is applicable. High-pressure steam taken direct from boilers can, of course, be passed through a reducing valve, with a view to lowering the pressure, but this method is somewhat wasteful, whilst as the steam is superheated in the reducing process,

the high temperature of the steam might, in some cases, be detrimental to the manufacturing process involved. The back-pressure turbine is applicable where the amount of steam required for heating is equal to or more than the amount required by the turbine for generating electricity, whilst in cases where the heating steam is less than that needed for producing current, the reducing turbine is most suitable, because it has a few additional elements in which the excess steam is utilised. The governing of these back-pressure turbines may differ with the conditions that prevail. If all the steam is required for heating purposes, independent of the load, an ordinary governor may be used, which will, of course, open or close the high-pressure throttle valve according to the load. But if, on the other hand, the turbine is required to work in parallel with other turbines or engines, and it is intended to utilise only the amount of steam required for heating purposes, the main throttle valve can be made to open and close according to the pressure in the exhaust pipe. Obviously, if more heating steam is required, the pressure in the heating steam main drops, and this variation in pressure can be utilised to open the main throttle valve in a similar way to that in which a reducing valve is made to open.

Westinghouse Back-Pressure Turbine.

Fig. 76 shows a section of a Westinghouse back-pressure turbine, having governing gear capable of controlling the supply of steam in accordance with either of these methods. But it is to be noticed that if, in the first case, the turbine is required to develop more load than that corresponding to the required volume of heating steam, a certain amount of steam passed through the turbine must be discharged into the atmosphere, which is very wasteful practice. The other method of governing, however, is quite satisfactory in this respect, but it is necessary to run the turbines in parallel with other engines, and the load must be distributed according to the amount of heating steam needed. In many cases a reducing turbine is much more satisfactory, for if the load on the turbine represents more exhaust steam than is wanted for heating purposes, the surplus steam is bye-passed to low-pressure wheels fixed on the turbine shaft and enclosed in the same cylinder as the other wheels. The Westinghouse Co. builds a reducing turbine on the Rateau principle, and having governing gear similar to that fitted to the Company's mixed-pressure turbines.

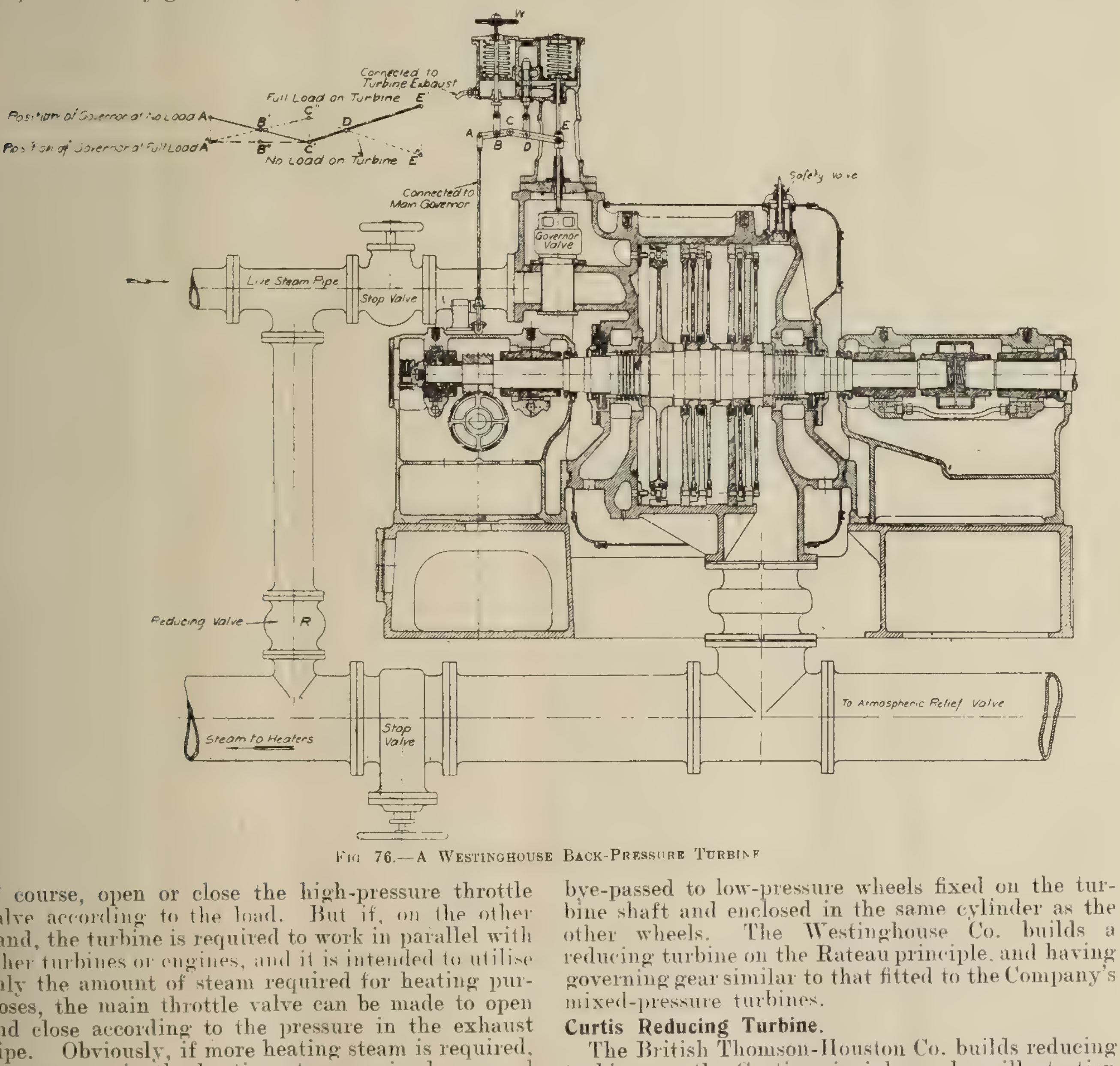


Fig. 76.—A Westinghouse Back-Pressure Turbine

Curtis Reducing Turbine.

The British Thomson-Houston Co. builds reducing turbines on the Curtis principle, and an illustration of one of these machines is shown in Fig. 77. It will be gathered that it is a two-stage machine, the high-pressure steam being expanded to low-pressure steam in the first stage, and the supply of low-pressure steam for heating or other purposes is delivered to the low-pressure supply system through a branch be-

tween the high and low-pressure stages. By means of the regulating piston just above the low-pressure steam connection, a constant low-pressure is maintained. A large floating horizontal lever is coupled up to this piston, and the lever is also connected by means of rods to the high and low-pressure valves, whilst another rod connects the lever to an oil-operated piston and slide valve. The latter are controlled by the governor, which operates on the principle previously described in connection with the British Thomson-Houston high-pressure turbines. The position of the regulating piston is determined by the relative pressures acting upon the two sides of the piston, the latter moving until the pressure of the steam balances that of the spring pressing against its upper surface. Clearly, if the steam pressure rises, the piston moves in an upward direction and compresses the spring above it, whilst if the steam pressure falls, the piston moves downwards. Assuming first that the steam pressure has increased, then the regulating piston moves up and takes with it the horizontal floating lever, which in turn takes up the

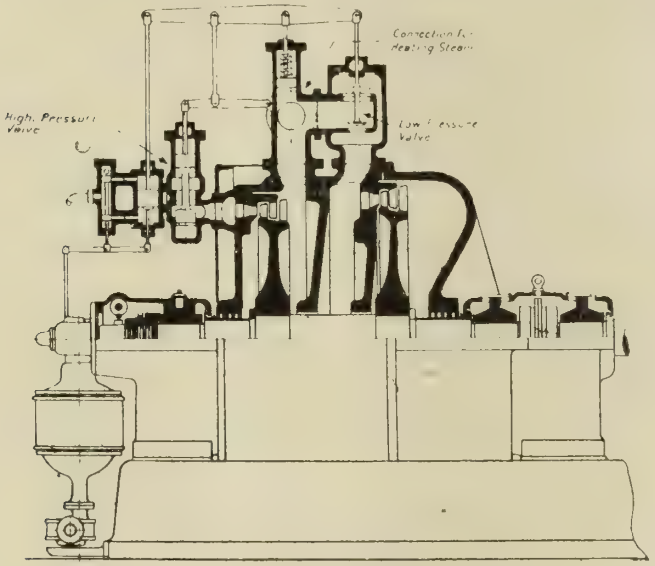


Fig. 77.—A B.T.H. Reducing Turbine.

high and low-pressure valve rods. The effect is that the high-pressure inlet piston valve is closed, and the low-pressure steam valve opened, thus tending to reduce the steam pressure in the chamber between the high and low-pressure stages, and restoring equilibrium. But if the pressure in this chamber is tending to fall, the reverse operation occurs; that is to say, the high-pressure valve opens and the low-pressure valve closes, and consequently the pressure in the chamber remains constant. In the event of the speed of the turbine tending to rise in consequence of a variation of the load, the governor operates the slide valve so as to admit oil to the under side of the oil-operated piston shown on the left, and this has the effect of raising the left-hand end of the horizontal floating lever, which pivots on the point to which the rod from the regulating piston is attached. In moving in this manner the floating lever tends to close the high and low-pressure valves, thus preventing an increase of speed, and at the same time keeping the pressure of the steam for the auxiliary supply constant. When the turbine's speed tends to drop the action is similar, but, of course, in this case, the high and low-pressure valves both open. It will thus be seen that the normal governing of the turbine and of the pressure supplied to the low-pressure system is automatic. As long as there is sufficient load on the turbine to utilise the energy obtained by expanding the amount of steam required for the auxiliary supply from the higher pressure to the lower pressure, the proper supply of low-pressure steam is maintained. But if the load is insufficient to provide the necessary low-pressure volume, the governor will, of course, only allow sufficient steam to pass to meet the demand of the load prevailing, and the extra steam required for heating will have to be passed through a reducing valve, brought into action automatically when the steam pressure on the heating main falls below a predetermined value.

(To be continued.)

COAL ECONOMY: FACTS OF INTEREST TO MILL ENGINEERS.

By Mr. W. M. Miles, of the Board of Trade.

(Continued from page 127.)

Amount of Air Required to Burn Coal.

With reference to the amount of air required to burn coal, it is necessary to know the composition of same, and for this an ultimate analysis must be made.

It is also necessary to find the loss under ideal conditions, that is, with the theoretical amount of CO_2, and consequently no excess of air, the ultimate analysis, final flue gas temperature, temperature of the air supplied for combustion, will be required; the following being the method of application to determine same.

Then $\frac{(2{\cdot}1571 - {\cdot}019)}{23} \cdot 100 = 9{\cdot}166$ lbs. of air required.

Composed of 2.1081 lbs. of oxygen and 7.0579 lbs. of nitrogen, and calculating further from the carbon-dioxide produced and amount of nitrogen present, we can find the theoretical amount of carbon-dioxide available, which is 17.75 per cent; the latter varies with the combustible contents of the sample of coal, whether good or bad, but is generally between 17.75 and 19.0 per cent.

Loss under ideal conditions, taking flue gases at 360 deg. Fah. and air for combustion 60 deg. Fah., British thermal units in coal 10,980. Loss due to waste heat = Total products × sp. ht. × $T - t$.

Lbs.		Units.
2,3943	CO_2 ·2161 300	155·6
7,0579	N_2 ·2410 300	517·0
073	Moisture (in coal) heated from 60 deg. to 212 deg.	11·1
073	Moisture evaporated from and at 212 deg.	70·5
073	Steam heated from 212 deg. to 360 deg.	5·2
4500	Water (from combustion) heated from 60 deg. to 212 deg., finally to steam at 360 deg.	536·0
		1295·4

Hence loss would be $\frac{1295 \times 100}{10980} = 11{\cdot}8$ per cent.

That is 11.8 per cent loss, without excess air or waste fuel in ash. There are works, however,

entailing from 30 to 40 per cent in this direction, apart from unburnt fuel dumped as ash.

$$\text{Then } \frac{2{\cdot}557 - {\cdot}058 \times 100}{23} = 10{\cdot}387 \text{ lbs. of air}$$

required containing 7.998 lbs. nitrogen and 2.38 lbs. oxygen, the theoretical percentage of CO_2 available being 18.16 per cent.

Loss under ideal conditions, taking flue gases at 460 deg. Fah., air 60 deg., British thermal units in coal 12,580.

Lbs.		
2.7900 C.O_2	·2164 × 400	241·5
7.9980 N.	·2440 × 400	780·0
·0813 Moisture (in coal)		100·6
·4800 Water (from combustion)		570·0
		1692·1

$$\text{Hence loss would be } \frac{1692{\cdot}1 \times 100}{12{,}500} = 13{\cdot}55 \text{ per cent.}$$

Coal cannot be allowed to burn of its own free will, and in practice the aim is to burn as much coal per square foot of grate, efficiently, as possible. Now this means that air must pass over this coal quick enough to accelerate combustion; more than that, there must be an excess of air.

Take a boiler fitted with two chain grates 12 ft. by 8 ft., that is, 192 square feet in all burning coal at the rate of 25 lbs. per square foot per hour, and calculate the weight and volume of air necessary to burn it completely, assuming each pound of coal required 10 lbs. of air.

1 lb. of air = 12.7 cubic feet, or 13, approximately. Therefore, 1 lb. of coal will require 13 × 10 = 130 cubic feet, and for the whole square foot 13 × 10 × 25 = 3,250 cubic feet of air per hour, the whole 192 square feet taking 3,250 × 192 = 624,000 cubic feet per hour.

Assuming the theoretical percentage of CO_2 available to be 18 per cent, the latter would be the amount of air required to burn the coal; in practice, however, this does not obtain, and we find the CO_2 to be anything from 3 per cent to about 14 per cent.

	192 cub. ft. Chain Grate.	24 cub. ft. Lancashire.
Hence 18 per cent C.O_2 would mean	624,000 Cub. ft.	78,000 Cub. ft.
Hence 9 per cent C.O_2 would mean	1,248,000	156,000
Hence 4 per cent C.O_2 would mean	2,710,000	339,000

This figure shows a great excess of air is being admitted; not only is it heated up at the expense of the coal, but fans passing it through the boiler use more energy than is necessary.

From the foregoing, it is seen that two things are being dealt with—coal which varies considerably, and air which is fairly constant. If the average fireman could be made to realise the combination between them, much more useful work would be done by the boiler.

Say a man has 4-in. fires, and his dampers half open, and a demand comes for steam; he thickens the fire, opens the damper full out, and forgets to close it, and perhaps for the rest of the day wastes useful heat in passing excess air through the boiler.

Another man complains that he cannot burn the coal off; generally he has the fires too thick, so much so that the chimney or fan cannot supply the amount of air necessary to burn it; in any case, he cannot burn the coal, but instead lets it be dumped as ash, and some other poor chap (in the case of a battery of boilers) has to take the pull, whereas by thinning his fires he would probably have done a better share of the load.

The following are the actual results on test conditions compared with returns of a careless fireman:—

Distribution of Heat (Test Conditions).	Per cent.
Heat taken up by boiler	76
Heat taken up by economiser	6
Heat taken up by radiation	3
Heat lost in chimney gases	12
Heat lost as unburnt fuel	3
	100

In the case of a careless fireman, however, conditions can change considerably. Take a case in point:—

Distribution of Heat (Case No. 2).	Per cent.
Heat taken up by boiler	60
Heat taken up by economiser	8
Heat taken up by radiation	3
Heat lost in chimney gases	19
Heat lost in unburnt fuel	10
	100

It will be readily seen by comparing the two examples where most of the heat is lost, the first being exit gases. These, in a fairly clean boiler, should not be more than 12-15 per cent; the chief cause is excess of air and insufficient knowledge of the principles of combustion. Coal requires a certain amount of air; some coals require more than others, but the average fireman does not apparently realise it.

The other item where a considerable amount of loss is entailed is in the matter removed from the boiler called ash, whereas sometimes it contains pieces of coal, any amount of coke, and in some cases a fair amount of riddlings, which are either precipitated there by the motion of the grate, or by the fireman when raking the fires.

In any case, No. 2 shows a loss of 10 per cent, which, with proper management, should not be more than 3-4 per cent, which is a fairly responsible allowance.

From coals Nos. 1 and 2, it appears that the more carbon and hydrogen coal contains, the more air is required to burn it; theoretically, that is the case, and if practicable in a boiler, less air would be used for poor coal. Now, the size of coal plays a very important part; assume coal to vary in quality but of constant and suitable size, we could burn inferior coal, because air could pass freely through it and be regulated easily; in practice, however, we find the poorer grades of slack require more air, chiefly because of the size, which is sometimes very small, the coal lying compactly like sand, and an extra amount of air has to be used to overcome this baffle of small or inferior coal. It has the same effect as tubes or passages in a boiler; when choked with grit and flue dust they obstruct the air passage, and the boiler will not do its correct amount of work until the grit is removed, because of the reduction in draught.

(To be continued.)

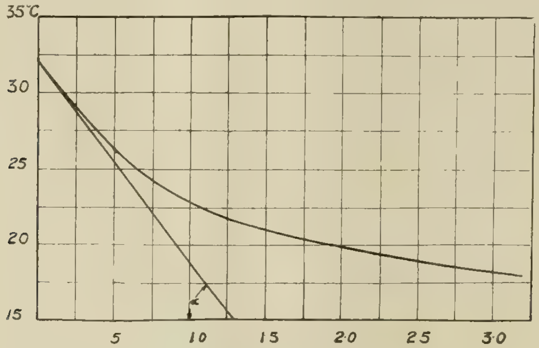
ON THE DETERMINATION OF THE TEMPERATURE RISE OF OIL CIRCUIT BREAKERS.

By G. E. Gittens, B.Sc. (Lond.).

(*Concluded from page 124.*)

Tank Losses.

When dealing with steel tanks for heavy current switches the designer has to estimate the probable watt loss due to the alternating current flux which passes into the tank walls. It is always advisable, where possible, to check the calculated figure by direct experiment. This can readily be done if a low voltage step-down transformer be available, by supporting a U-shaped



Determination of Temperature Rise.—Fig. 6.

copper conductor in the empty tank in the same relative position as the stationary stems and brush will occupy.

Thermometers are then put at suitable points on the tank, and current at the rated frequency sent through the conductor until the readings of the thermometers are stationary.

Data for a cooling curve are then obtained and the rate of cooling at the steady temperature at once found. Curve Fig 6 is plotted from a set of such readings taken on an oil switch tank. The steady temperature was 32°C. and the slope of the curve obtained by drawing the tangent at this point is $\frac{d\theta}{dt} = \cdot 22$ C° per minute.

The mass of the tank affected was estimated as 110 lbs. Assuming the specific heat of the steel to be 3·8 watt min. per lb. per C° the loss would be :—

Watts = 110 lbs. $\times$ ·22C° per min. $\times$ 3·8 watt min. per lb. per C° = 92.

As an illustration of the methods employed, the following example is given for an oil switch rated at 2,000 amperes on 50 periods :—Each stationary stem is built up of strap copper $1\frac{1}{8}$ in. $\times$ $\frac{5}{16}$ in. 6 in. parallel, and having a mean length of $28\frac{1}{2}$ in.

Taking the specific resistance of commercial copper at 50°C as $\rho = \cdot 765 \times 10^{-6}$ sq. in. ohms per inch, the ohmic resistance would be

$$R = \frac{l\rho}{S} = \frac{28\cdot5 \times \cdot765 \times 10^{-6}}{2\cdot11}$$
$$= 10\cdot3 \times 10^{-6} \text{ ohms.}$$

The apparent watt loss per phase on 2,000 amperes is

$$2{,}000^2 \times 10\cdot3 \times 10^{-6}$$
$$= 83 \text{ watts.}$$

Add 50 per cent for eddy current loss
= 124 watts.

The effective "drop" over brush and two contacts is taken as 12 millivolts, giving a further loss of

$$2{,}000 \times \cdot012 = 24 \text{ watts.}$$

Total copper loss = 124 + 24 watts.
= 148 watts.
Tank loss per switch phase = 100 watts.
Total loss per switch phase = 148 + 100
= 248 watts.

Now the whole of this loss has to be dissipated by the effective tank surface estimated as 1260 sq. in., and hence the specific watts are $\frac{248 \text{ watts}}{1260 \text{ sq. in.}} = \cdot197$ watts per sq. in.

The temperature rise may now be determined from the expression $w = \cdot0026\theta^{1\cdot25}$

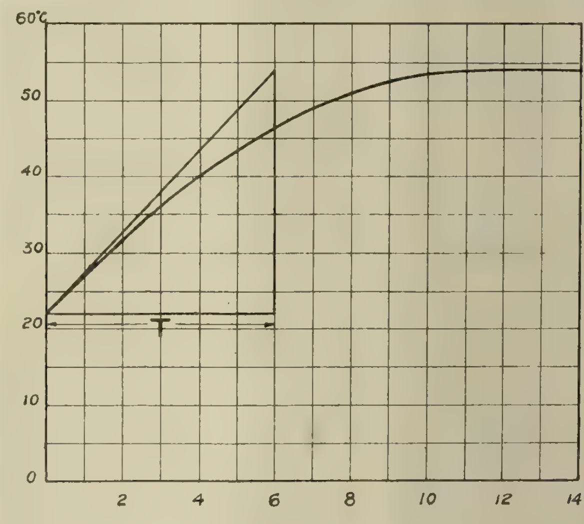
where w = specific watts.
and θ = temperature rise.

Inserting values we have $\cdot197 = \cdot0026\theta^{1\cdot25}$, and $\therefore$ $\theta^{1\cdot25} = 76$.

Taking logs 1·25 log θ = log 76 = 1·88, whence log θ = 1·5 and θ = 32C°.

Thermal Capacity.

This is defined as the product of the mass of the body and its specific heat and for an oil switch will comprise the sum of that for the copper, the steel, and the oil.



Determination of Temperature Rise.—Fig. 7.

In estimating these items assume 100 per cent of the copper and 60–80 per cent of the oil and tank (depending upon the shape of the tank and the type of the switch) are active for this purpose, and take the respective specific heats as—

Copper = 3 watt min. per lb. per C°
Steel = 3·8 min. ,, ,,
Oil = 14·0 min. ,, ,,

We then have for the switch considered :—

For the copper = 62 lbs., thermal capacity = 186 watt min. /C°

For the tank and steel parts = 137 lbs., thermal capacity = 520 watt min. C°
For the oil = 155 lbs., thermal capacity = 2,170 watt min. /C°

Total thermal capacity = 2,876 watt min. /C°.

Heating time constant

$$= \frac{\text{Total thermal capacity}}{\text{Emissivity} \times \text{effective radiating surface}}$$

Inserting values we have

$$T = \frac{2{,}876 \text{ watt min. per C}}{\cdot 006 \text{ watt / sq. in. / C}^\circ \times 1{,}260 \text{ sq. in.}}$$
$$= 380 \text{ min.} = 6{\cdot}3 \text{ hours.}$$

The values for the emissivity and the effective tank surface will depend upon the nature of the tank surface and the disposition of the lining and is a matter for judgment and experience with a given class of tank, but it will generally be found that 60–80 per cent of the tank surface excluding the bottom is useful for radiating purposes, and that ·006 watts per sq. in. per C° is an average value for the emissivity.

The temperature rise may also be arrived at as follows :

$$\text{Assume } \theta_m = \frac{WT}{k}$$

Where θ_m = maximum temperature rise
T = heating time constant
W = total watts dissipated per tank
k = heat required to raise tank and contents 1 C°, radiation being neglected,

$$\text{then } \theta_m = \frac{248 \text{ watts} \times 380 \text{ minutes}}{2876 \text{ watt min. per C}^\circ}$$
$$= 33\text{C}^\circ$$

An inspection of the heating curve for this switch (Fig. 7) gives the heating time constant as six hours, and the temperature rise over an air temperature of 22°C as 32C°.

(Concluded.)

HYDRO-ELECTRIC SURVEY OF INDIA.

In a recent communique, the Government of India have announced their intention of dealing with the long overdue problem of ascertaining the amount of water-power available for electrical developments. It may be surmised that this is due to the Indian Industrial Commission, though why it should require a commission to initiate an enquiry of so obvious a nature is hard to fathom. The solution to this enigma may perhaps be found in the correspondence which lately appeared in one of our leading daily contemporaries, namely the apathy of the P.W.D. to everything outside its own preserve of roads and buildings and irrigation.

Enormous use has been made of the great rivers of India for irrigation purposes, says *Indian Industries and Power*, and it is clear that whatever further developments are undertaken for power must not interfere with the great canal systems. It is no doubt for this reason that the Government have appointed one of the senior officers of the Irrigation Department, Mr. G. T. Barlow, C.I.E., to conduct the preliminary enquiries. Whether we are dealing with high-fall projects in the hills or with canal falls in the plains, electric development involves no loss of water; but in the former case there may be instances where the piping of the supply down some thousands of feet would deprive the cultivator of the water which his own little channels have utilised from time immemorial at some intermediate point. Obviously this must be guarded against, and the necessary flow to these channels assured. The small flour mills which are a feature of every hill station —standing examples of inefficiency, but suited to the simple folk who use them—can no doubt be equipped either with electric motors or with turbines less wasteful of water.

A greater difficulty than these is that where water is scarce it cannot be allowed to run away at times when it is not required for irrigation; and yet a hydro-electric plant cannot carry on if its supply is stopped. No doubt it may be possible in the case of industrial works to shut down completely during the annual closure, but if towns are also supplied this may involve steam reserve plant and increased capital cost. But apart from the closure, storage on a large scale may often be necessary to enable the plant to be kept working when the demand for irrigation water is low. In Bombay we have the greatest example in the world of storage for hydro-electric work, and unfortunately the ground in other parts of India is often much less favourable for large dams.

There is some danger that the enquiry may be conducted on lines too conservative. Great though the interests of irrigation may be—and agriculture is, of course, by far the largest industry—the need for other local industries is also urgent, as the war has shown. The problems which the hydro-electric engineer has to face are in many respects quite different to those met by the irrigation engineer. Government have therefore "decided to associate with Mr. Barlow, Mr. J. Meares, Electrical Advisor to the Government of India, who will advise him upon the electro-technical aspects of the case." It would appear from the communique that this "association" of an electrical engineer in the survey is to be of a more or less casual and subordinate nature, and our sympathies are with Mr. Meares. The whole engineering profession owes him a debt of gratitude for his clear exposition of electrical problems in his well-known works. His chapter on water-power contains much valuable information on a subject which is very little understood.

At present the total power developed from water in India is in the region of 100,000 H.P., out of the millions that must be available. With a few notable exceptions, private enterprise has made little attempt to develop this natural resource of wealth, despite the high cost of fuel. We want some more men of broad mind and well-lined pocket, and a sure reward awaits them. We are not afraid that Bombay will lose her pre-eminence, but we should like to see other provinces rivalling her. No doubt Government will have to come forward in the first instance, for large power schemes must have an industrial outlet for their power; the supply of towns can be only a by-product. Statistics show that the working costs of large town supply companies using fuel are about three-quarters of an anna per unit of electricity, while even self-contained railway works,

situated in coalfields, cannot generate at a cost below one-quarter of an anna, despite a high-load factor. With water power developed on a large scale, it should be possible—and it must be possible if we are to go forward—to generate at far below one-tenth of an anna, so that even when capital charges are taken into account, power can be sold at about that figure. These considerations should afford Messrs. Barlow and Meares much food for thought during their investigation; we wish them success.

REPAIRING STEAM BOILERS BY OXY-ACETYLENE WELDING.

By Edward Ingham, A.M.I.Mech.E.

If a mixture of oxygen and acetylene in the proportion of about 1.5 volumes of the former to one of the latter be passed through a blow-pipe of suitable construction, a flame having a temperature of over 6,000 deg. Fah. is produced. This flame consists almost entirely of carbon monoxide (CO), which is converted into carbon dioxide (CO_2). It is surrounded by a larger zone of hydrogen gas, which prevents oxidation from taking place (and also loss of heat from the inner zone), because the temperature is too high for such combination to take place.

It will be seen that we have here a flame admirably suited for welding metals such as iron and steel, because since oxidation cannot occur, there is no fear of burning of the metal. In this respect, the oxy-acetylene welding process possesses a considerable advantage over other methods of welding.

Oxy-Acetylene Flame.

Within recent years the oxy-acetylene flame has been extensively used for making good certain defects in steam boilers, and so successful has it proved in this connection that an oxy-acetylene welding plant is to be found in almost every modern boiler works.

Repairs.

The repairs which may be effected are of a most varied nature. Fractures and grooves, for example, may be satisfactorily made good; defective portions of plate cut out and new pieces welded in; whilst parts which have been weakened either by internal or external corrosion may be thickened up to any extent desired by fusing in the flame pieces of steel wire. In marine work especially, most extensive repairs are frequently effected. Thus, new plates are welded into the bottom of the combustion chambers, and old furnaces renewed. In the latter case, the old furnace is first cut out by the same flame. The new furnace is then built up in three or four pieces, which are bolted firmly together, and after the whole has been put into position, the pieces are welded together. The new furnace is thus constructed without any objectionable riveted joints, which are always liable to give trouble by leakage.

Lancashire and Marine Boilers.

In Lancashire and marine boilers, acetylene welding is of special advantage for repairing defects in the furnace and flue tubes, particularly in the case of high-pressure boilers. For example, wasting commonly takes place about the bar level of the upper portions of the tubes, and the wasting may be filled up and the tubes thus brought up to their original strength. In cylindrical boilers, where the furnace tube rings are connected by means of Bowling hoops, the round of the hoop is often pitted or wasted through. In serious cases, such wasting necessitates the fitting of new hoops, or the making good of the wasting by acetylene welding. At the present time, Bowling hoops cannot be obtained, so that, if the existing hoops are to be replaced, flat rings must be applied. Now it will be evident that the substitution of a Bowling hoop by a flat ring will seriously reduce the strength of the tube to resist collapse, and hence such a method of repair, particularly if more than one hoop is affected, will necessitate a reduction in the working pressure of the boiler. The advantage of acetylene welding in such a case as this will thus be appreciated.

Scope of Application.

These preliminary remarks will serve to show that there is a very wide scope for the application of oxy-acetylene welding to boiler repairs. It is necessary, however, to point out that the field is limited, as, generally speaking, it is only certain parts which can be repaired by the method with perfect safety. In all welds, there is an element of uncertainty, and consequently a possibility of failure occurring. Welds produced by the oxy-acetylene process, or by other similar processes, are not, as a rule, so efficient as those produced by hammering, because the weld is more in the nature of a soldered joint, the parts adhering together rather than folding over and clasping one another as in the case of hammering. For this reason the welds should not be relied upon for withstanding very high stresses, particularly tensile stresses. When a part is in tension, the tendency is to tear the metal asunder, so that unless the welded part is absolutely reliable, a certain amount of risk of failure is involved. On the other hand, when the parts are in compression, the tendency is to close the metal together.

Conditions of Application.

Generally speaking, therefore, oxy-acetylene welding should be applied only to those parts of a boiler which are in compression. Thus, in Lancashire and Cornish boilers, since the tubes are in compression and the shell in tension, it is only defects which occur in the tubes which ought to be repaired by acetylene welding, although certain defects in the end plates may be dealt with satisfactorily if a due amount of care exercised. It may be remarked that the Board of Trade and the Boiler Insurance Companies will not sanction the carrying out of repairs on shell plates in tension.

Expert Advice.

In carrying out repairs by oxy-acetylene welding, it is necessary to give careful consideration to the question of what exactly is to be done. We know from experience that if the boilermakers' men are simply told that a certain defect wants making good, and are then left to do it in their own way, the results are liable to prove very unsatisfactory. The best course to take is to have defects examined by an expert, such as an inspector of a leading Boiler Insurance Company, who can then decide as to what repairs are necessary. When the work is put in hand it should be supervised from time to time. This is very important in the case of a boiler which is being repaired on its site, since once the plant has been

taken away, it is an expensive matter to bring it back again to make good any imperfections, or to enlarge upon the work already done.

In a recent instance, a large Lancashire boiler was repaired in two or three places, but one or two slight defects under the furnace tubes had escaped attention, with the result that the welders had to return from a considerable distance to finish the work, thus involving a great deal of unnecessary expense.

Skilled Operators.

In all cases of repairs by acetylene welding it is of the utmost importance that the men who carry out the work should, in addition to being skilled boiler-makers, be specially trained in this class of work. The importance of this is not generally recognised, boiler-making firms having in many instances put common labourers on to this class of work, starting first, perhaps, with a little cutting out, and gradually extending the scope of the work until most important repairs have been effected by these men, and, as a result, the work has often proved of a very inferior character.

Fractures.

Special attention needs to be given to the question of fractures, as unless great care is exercised, the atomic forces of expansion and contraction, which are practically irresistible, may be brought into play, giving rise to further fractures, or extending the fracture under consideration. To minimise this risk, a fairly large area of plate in the vicinity of the fracture should be carefully heated before the welding is commenced, the intensity of the heating being greatest about the fracture, and gradually tapering off towards the more remote portions of the plate. In locomotive and marine boilers, fractures commonly occur in the fire boxes or combustion chambers, and in dealing with such fractures it is necessary to remove the stays in the neighbourhood of the fracture before the work of welding is commenced. If this is not done, severe stresses are liable to be induced in the plate, which, when the stays are not removed, is too rigid to accommodate the movements of expansion and contraction set up during the heating and cooling of the metal.

In the case of portions of plate which are being cut out by the acetylene welding flame, and replaced, it is sometimes thought that the intense heat will injure the metal, rendering it hard and brittle, but experience seems to show that no injurious effect is produced, and that if a thin chipping be taken off all round the hole, any hardness there may be at the edges of the hole will be entirely removed.

Repairing End Plates.

Some misapprehension exists with regard to the advisability or otherwise of repairing fractures in the end plates of Lancashire and Cornish boilers by acetylene welding. If the ends are sufficiently stayed by gussets, this method of repair may be regarded as satisfactory, since even should the weld fail, there would be little risk of the end plate being blown out. In the case of dish-ended boilers, however, since there are no gussets to strengthen the ends, failure of a weld might lead to a disastrous explosion, and for this reason, repairs in the end plates of dish-ended boilers by acetylene welding are not to be recommended.

Second-hand Boilers.

Before concluding, it may be well to make a reference to the application of acetylene welding to the repair of second-hand boilers. Of late years the second-hand boiler trade has increased considerably, and at the present time, in particular, many firms are on the look-out for good second-hand boilers, and are prepared to give very high prices for these, especially in cases where they are unable to purchase new boilers. Prospective buyers would do well to bear in mind that old and worn-out boilers have, in numerous instances, been rendered apparently quite fit for a fresh term of service by unscrupulous dealers, who have not hesitated to have serious defects in the shell made good by acetylene welding. For example, boilers which have become nearly corroded through at the seatings have been brought up to the original thickness at the wasted part, whilst patches, which always go a long way towards preventing the sale of a boiler, have been removed and replaced by new plates carefully welded into position. When the work is carefully done, it is a difficult matter to discover that any such repairs have been effected, and for this reason, it is always advisable for an intending purchaser to have a boiler which he contemplates buying examined by a recognised boiler inspector. A qualified inspector will generally discover any evidence of acetylene welding, whereas a person unaccustomed to regular inspection, would fail to do so.

FIRST BRITISH-BUILT CONCRETE STEAMSHIP.

An event marking a very important advance in the development of ferro-concrete shipbuilding was the launch on January 7th of the first concrete steamship built in a British shipyard. Constructed in accordance with the Mouchel-Hennebique system from the designs jointly prepared by the Ferro-Concrete Ship Construction Co. Ltd., of Vickers House, London, S.W., as naval architects, and Messrs. L. G. Mouchel and Partners Ltd., of Victoria Street, London, S.W., as civil engineers, the vessel was built in the yard of the first-mentioned company at Barrow-in-Furness.

The dimensions are as follows:—Length between perpendiculars, 205 ft.; moulded breadth, 32 ft.; moulded depth, 19 ft. 6 in.; draught when loaded, 15 ft. 6 in.; indicated horse power, 400; and speed, $7\frac{3}{4}$ knots.

In respect of general design and construction, the vessel is similar to the 1,000-ton barges and 750-H.P. steam tugs which are being built at the same yard for the Ministry of Shipping, and as the concrete is moulded throughout in shuttering, a straight-line section is preserved as far as possible. The lines at the bow and stern, however, are rounded off so that the form of the vessel compares favourably with that of a steel ship of equal dimensions and capacity. Three spacious holds are provided for cargo, the boilers and machinery being placed aft.

Two marine-type boilers are provided, each 9 ft. long by 9 ft. 6 in. in diameter, and the engines are of the compound surface condensing type, capable of developing from 350 to 400 indicated horse power, at a working pressure of 130 lbs. per square inch. The deck equipment for handling cargo is very com-

plete, including three 3-ton derricks, three steam winches, and a steam windlass on the forecastle. The vessel is also to be fitted with a wireless installation.

We understand that the ship has been built partly with the object of obtaining practical data for guidance in the design of still larger steamships of the same class.

Although weighing more than steel ships of equal dead-weight capacity, ferro-concrete steamers possess the advantage of considerably greater cubical capacity. Consequently they will be able to carry proportionally larger cargoes of light and bulky freight, such as cotton, fruit, timber, silk, wool, and other products in great demand. This consideration and the lower initial cost and elimination of maintenance charges are some of the reasons which justify faith in the permanence of concrete shipbuilding.

UNDERCUTTING IN GENERATED INVOLUTE SPUR PINIONS.

ITS CAUSES AND PREVENTION.

By G. H. Middleton.

It is a very noticeable feature in involute gears cut by generating machinery that the pinions, if of fairly low numbers of teeth, have very pronounced undercutting of the tooth flanks, much to the detriment of the running qualities and wear-resisting capacity of the gears. In this article it is proposed to investigate the phenomenon, consider its causes, and suggest a method of overcoming the difficulties which arise therefrom.

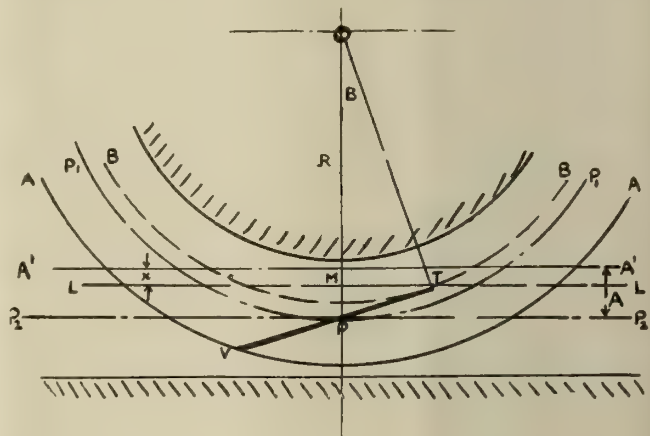
It is well-known by all who have any knowledge of gear theory that in order that the velocity rates of a gear pair shall be constant and uniform—not only during a revolution, but in minute fractions of a revolution—the following law, which can be proved in various ways, must hold good: *The common normal to the tooth curves at their point of contact must pass through the pitch point.* This law should be somewhat amplified, as it is not quite complete. As the contact of the pitch lines and the motion of the pitch point are continuous and progressive, the normals must also be arranged in a continuous and progressive manner. That is, they must follow without a break or crossing, not only springing from the tooth curve at consecutive points, but cutting the pitch circle at consecutive points, each point on the pitch line becoming the pitch point in turn, and the normal cutting the pitch line at that point must be through, and normal to, both tooth curves at that instant. Any overlapping of the normals will cause a "cusp" on the tooth contour, and hence a break in the continuity of action and irregular, jerky motion will ensue. Such a cusp can be noticed on an undercut pinion.

Any tooth contour which fulfils the above conditions of contact is termed an "odontoid," or pure tooth curve, and consequently we can state that for perfect running all tooth curves (shapes) must be odontoidal. There are two or three different systems of interchangeable odontoids, the two best known being the cycloidal or double-curve tooth, and the involute or single-curve tooth. We will pass over the former, because the involute system is the only really practical one, the cycloidal having practically gone out of use. The reasons for the now almost universal acceptance of the involute are as follows:—

Firstly: The line of action is a perfectly straight line at an angle with the line of tangency to the pitch circles, known as the pressure angle, which varies in magnitude from 14½ deg. to 22½ deg. The thick lines in the figures denote the line of action (or line of contact). This fixes the rack tooth of the system as a straight-sided tooth, with its sides at 90 deg. *minus* pressure angle to its pitch line.

Consequently, as the rack is straight-sided, the system readily lends itself to easy generation of tooth curves by the use of rack-shaped planing cutters, or spiral racks—gashed to form cutting edges—known as hobs. These tools having straight sides are comparatively easy to produce to a high commercial standard of accuracy.

Secondly: The involute system has an advantage over all others, in that having only a single curve, gears can run correctly at larger or smaller than standard centres. Backlash, of course, occurs if the



Nomenclature: AA = Pinion Addendum Line; P_1P_1 = Pinion Pitch Line; BB = Base Circle of Pinion; B = Pressure Angle of System; A^1A^1 = Rack Addendum Line; P_2P_2 = Rack Pitch Line; LL = Interference Line; VT = Line of Action (or Contact).

Fig. 1.—Undercutting in Generated Involute Spur Pinions.

centres are wide, but the mathematical action still continues, and the velocity ratio is unchanged. This serves to somewhat illustrate the flexibility of the involute system, and is a point to which we shall refer later.

Undercutting is caused by "interference," and the two actions occur together. Interference, as its name suggests, is the interfering of one odontoid with a mating odontoid, causing one to be cut away for a certain distance, which depends upon numbers of teeth, pressure angle, and tooth height. In gear generation it is caused when a generating tool has a larger possible approach contact than has the gear or pinion to be cut, and as the tool is generally of rack section, the maximum undercutting action is noticed, the rack, of course, being the largest "gear" of a set.

We will therefore consider the limits below which interference between rack and pinion commences, and thence suggest a remedy for undercutting. This will follow from the understanding of the conditions,

Weights of Lengths of Rolled Steel Sections.

Beam $10\frac{1}{2}$ in. × $10\frac{1}{2}$ in. × 65 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	5 3 6	11 2 12	0 17 1 18	1 3 0 24	1 9 0 2	1 14 3 8	2 0 2 14	2 6 1 20	2 12 0 26	0
1	0 2 9	6 1 15	12 0 21	0 17 3 27	1 3 3 5	1 9 2 11	1 15 1 17	2 1 0 23	2 7 1 0	2 12 3 7	1
2	1 0 18	6 3 24	12 3 2	0 18 2 8	1 4 1 14	1 10 0 20	1 15 3 26	2 1 3 4	2 7 2 10	2 13 1 16	2
3	1 2 27	7 2 5	13 1 11	0 19 0 17	1 4 3 23	1 10 3 1	1 16 2 7	2 2 1 13	2 8 0 19	2 13 3 25	3
4	2 1 8	8 0 14	13 3 20	0 19 2 26	1 5 2 4	1 11 1 10	1 17 0 16	2 2 3 22	2 8 3 0	2 14 2 6	4
5	2 3 17	8 2 23	14 2 1	1 0 1 7	1 6 0 13	1 11 3 19	1 17 2 25	2 3 2 3	2 9 1 9	2 15 0 15	5
6	3 1 26	9 1 4	15 0 10	1 0 3 16	1 6 2 22	1 12 2 0	1 18 1 6	2 4 0 12	2 9 3 18	2 15 2 24	6
7	4 0 7	9 3 13	15 2 19	1 1 1 25	1 7 1 3	1 13 0 9	1 18 3 15	2 4 2 21	2 10 1 27	2 16 1 5	7
8	4 2 16	10 1 22	16 1 0	1 2 0 6	1 7 3 12	1 13 2 18	1 19 1 24	2 5 1 2	2 11 0 8	2 16 3 14	8
9	5 0 25	11 0 3	16 3 9	1 2 2 15	1 8 1 21	1 14 0 27	2 0 0 5	2 5 3 11	2 11 2 17	2 17 1 23	9

Weight of Beam, advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight.	lbs.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q lbs.	q. lbs.	Weight.
	5·41	10·83	16·25	21·66	27·08	1 4·50	1 1·91	1 15·33	1 20·75	1 26·16	2 3·58	2 9	

Weights of Lengths of Rolled Steel Sections.

Beam $10\frac{1}{2}$ in. × $10\frac{1}{2}$ in. × 65 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft
0	..	2 18 0 4	5 16 0 8	8 14 0 12	11 12 0 16	14 10 0 20	17 8 0 24	20 6 1 0	23 4 1 4	23 2 1 8	0
10	0 5 3 6	3 3 3 10	6 1 3 14	8 19 3 18	11 17 3 22	14 15 3 26	17 14 0 2	2) 12 0 6	23 10 0 10	26 8 0 14	10
20	0 11 2 12	3 9 2 16	6 7 2 20	9 5 2 24	12 3 2 0	15 1 3 4	17 19 3 8	20 17 3 12	23 15 3 16	6 13 3 20	20
30	0 17 1 18	3 15 1 22	6 13 1 26	9 11 2 2	12 9 1 6	5 7 2 10	18 5 2 14	21 3 2 18	24 1 2 22	26 19 2 26	30
40	1 3 0 24	4 1 1 0	6 19 1 4	9 17 1 8	12 15 0 12	5 13 1 16	18 11 1 20	?1 9 1 24	21 7 2 0	27 5 2 4	40
50	1 9 0 2	4 7 0 6	7 5 0 10	10 3 0 14	13 0 3 18	15 19 0 22	18 17 0 26	21 15 1 2	24 13 1 6	27 11 1 10	50
60	1 14 3 8	4 12 3 12	7 10 3 16	10 8 3 20	13 6 2 24	16 5 0 0	19 3 0 4	22 1 0 8	24 19 0 12	27 17 0 16	60
70	2 0 2 14	4 18 2 18	7 16 2 22	10 14 2 26	3 12 2 2	16 10 3 6	19 8 3 10	22 6 3 14	25 4 3 18	23 2 3 22	70
80	2 6 1 20	5 4 1 24	8 2 2 0	11 0 2 4	13 18 1 8	16 16 2 12	19 14 2 16	'2 12 2 20	25 10 2 24	28 8 3 0	80
90	2 12 0 26	5 10 1 2	8 8 1 6	11 6 1 10	14 4 1 14	17 2 1 18	20 0 1 22	22 18 1 26	25 16 2 2	28 14 2 6	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight
	29 0 1 12	58 0 2 24	87 1 0 8	116 1 1 20	145 1 3 4	174 2 0 16	203 2 2 0	232 2 3 12	261 3 0 24	290 3 2 8	

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Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 10 in. × 10 in. × 55 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs	Ft
0	..	4 3 18	9 3 8	14 2 26	0 19 2 16	1 4 2 6	1 9 1 24	1 14 1 14	1 19 1 4	2 4 0 22	0
1	0 1 27	5 1 17	10 1 7	15 0 25	1 0 0 15	1 5 0 5	1 9 3 23	1 14 3 13	1 19 3 3	2 4 2 21	1
2	0 3 26	5 3 16	10 3 6	15 2 24	1 0 2 14	1 5 2 4	1 10 1 22	1 15 1 12	2 0 1 2	2 5 0 20	2
3	1 1 25	6 1 15	11 1 5	16 0 23	1 1 0 13	1 6 0 3	1 10 3 21	1 15 3 11	2 0 3 1	2 5 2 19	3
4	1 3 24	6 3 14	11 3 4	16 2 22	1 1 2 12	1 6 2 2	1 11 1 20	1 16 1 10	2 1 1 0	2 6 0 18	4
5	2 1 23	7 1 13	12 1 3	17 0 21	1 2 0 11	1 7 0 1	1 11 3 19	1 16 3 9	2 1 2 27	2 6 2 17	5
6	2 3 22	7 3 12	12 3 2	17 2 20	1 2 2 10	1 7 2 0	1 12 1 18	1 17 1 8	2 2 0 26	2 7 0 16	6
7	3 1 21	8 1 11	13 1 1	18 0 19	1 3 0 9	1 7 3 27	1 12 3 17	1 17 3 7	2 2 2 25	2 7 2 15	7
8	3 3 20	8 3 10	13 3 0	18 2 18	1 3 2 8	1 8 1 26	1 13 1 16	1 18 1 6	2 3 0 24	2 8 0 14	8
9	4 1 19	9 1 9	14 0 27	19 0 17	1 4 0 7	1 8 3 25	1 13 3 15	1 18 3 5	2 3 2 23	2 8 2 13	9

Weight of Beam, advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight
	4·58	9·16	13·75	18·33	22·92	27·50	1 4·08	1 8·67	1 13·25	1 17·81	1 22·42	1 27	

Weights of Lengths of Rolled Steel Sections.

Beam 10 in. × 10 in. × 55 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	Ft
0	..	2 9 0 12	4 18 0 24	7 7 1 8	9 16 1 20	2 5 2 4	14 14 2 16	17 3 3 0	19 12 3 12	22 1 3 24	0
10	0 4 3 18	2 14 0 2	5 3 0 14	7 12 0 26	10 1 1 10	12 10 1 22	14 19 2 6	17 8 2 8	19 17 3 2	22 6 3 14	10
20	0 9 3 8	2 18 3 20	5 8 0 4	7 17 0 16	10 6 1 0	12 15 1 12	15 4 1 24	17 13 2 8	20 2 2 20	22 11 3 4	20
30	0 14 2 26	3 3 3 10	5 12 3 22	8 2 0 6	10 11 0 18	13 0 1 12	15 9 1 14	17 18 1 26	20 7 2 10	22 16 2 22	30
40	0 19 2 16	3 8 3 0	5 17 3 12	8 6 3 24	10 16 0 8	13 5 1 2	15 14 1 4	18 3 1 16	20 12 2 0	23 1 2 12	40
50	1 4 2 6	3 13 2 18	6 2 3 2	8 11 3 14	11 0 3 26	13 10 0 20	15 19 0 22	18 8 1 6	20 17 1 18	23 6 2 2	50
60	1 9 1 24	3 18 2 8	6 7 2 20	8 16 3 4	11 5 3 16	13 15 0 0	16 4 0 12	18 13 0 24	21 2 1 8	23 11 1 20	60
70	1 14 1 14	4 3 1 26	6 12 2 10	9 1 2 22	11 10 3 6	13 19 3 18	16 9 0 2	8 18 0 14	21 7 0 26	23 16 1 10	70
80	1 19 1 4	4 8 1 16	6 17 2 0	9 6 2 12	11 15 2 24	14 4 3 8	16 13 3 20	19 3 0 4	21 12 0 16	24 1 1 0	80
90	2 4 0 22	4 13 1 6	7 2 1 18	9 11 2 2	12 0 2 14	14 9 2 26	16 18 3 10	19 7 3 22	21 17 0 6	24 6 0 18	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft
Weight	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb.	t. c. q. lb	t. c. q. lb	t. c. q. lb	t. c. q. lb.	t. c. q. lb	Weight
	24 11 0 8	49 2 0 16	73 13 0 24	98 4 1 4	122 15 1 12	147 6 1 20	171 17 2 0	196 8 2 8	220 19 2 16	245 10 2 24	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

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THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN. —Applications are invited for the position of ASSISTANT SECRETARY. Applicants must be members of the A.E.S.D. Organising ability essential. Salary, £350 per annum, rising by annual increments of £25 to £400. Address:—General Secretary, 8, Victoria Street, London, S.W.1. Envelopes to be marked "Assistant."

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PERSONAL NOTES.

Mr. Allen T. Young has resigned his position as general manager of the British Electric Plant Co. Ltd., of Glasgow and Alloa, with a view to going abroad.

Mr. Sidney J. Ebbutt, one of the London outdoor representatives of W. T. Henley's Telegraph Works Company, has been released from military service, and has rejoined the company.

Messrs. Thermit Limited announce that **Mr. Cecil Leigh, F.I.C.,** for many years chief chemist of the Birmingham Metal and Munitions Company Limited, has been appointed general manager of the company.

Mr. H. C. Babb, for three years resident engineer and manager at Bo'ness Electricity Works, has been appointed general manager of Musselburgh and District Tramways and Lighting Company.

The Institution of Civil Engineers, at the meeting held on Jan. 28th, elected upon its roll of distinguished honorary members **Marshal Foch, O.M., Field-Marshal Sir Douglas Haigh, K.T., Admiral Viscount Jellicoe of Scapa, G.C.B., O.M.**

Mr. W. Anderson, who has been with the General Electric Company (Glasgow branch) for over 12 years, has resigned his position in order to become joint manager of Messrs. Wood and Cairns Limited, at their Glasgow branch.

Messrs. Dick, Kerr and Co. Limited have purchased the Ashton Park estate at Preston, of about 90 acres, with a view, it is understood, of providing a recreation park for the employees. Probably some portion of the park will be used for housing.

Mr. W. T. Bower, late of the Metallic Seamless Tube Company, and the Metallic Electrical Engineering Company, has accepted an appointment as managing director of the Electrical Components Limited, Norfolk House, 36, Cannon Street, Birmingham, switchgear and heating manufacturers.

Messrs. Drake and Gorham Limited announce that owing to the expiration of the lease of their present offices in Manchester, they have removed to 29, Piccadilly, Manchester. The telephone number of the firm is 3700, and their telegraphic address, "Accumulator, Manchester," remains unchanged.

The directors of **Messrs. William Muirhead and Co. Limited,** of 40, Parliament Street, Westminster, London, call attention to the altered designation of their firm, which will in future be William Muirhead, Macdonald Wilson and Co. Limited. The constitution of the company remains unaltered.

Mr. Richard J. Howley, M.Inst.C.E., has resigned his position as joint manager of the British Electric Traction Company in order to take up private practice. Mr. Howley will continue to act as chairman of the Potteries Electric Traction Company and of the Birmingham and Midlands Motor Omnibus Company, and in an advisory capacity to the British Electrical Federation.

Mr. Henry Joseph, A.M.I.E.E., has, on demobilisation, resigned his post as engineer and manager to the Urban Electric Supply Company Limited at Hawick, in order to start a business at Birmingham as a specialist in electric drive in factories, and the repair and maintenance of motors. His firm will be known as the Midland Electric Power Installation Company, and the temporary offices will be 16, Holly Road, Edgbaston, Birmingham.

Mr. J. M. Kennedy, O.B.E., M.Inst.C.E., has resigned his position under the Ministry of Munitions as Superintendent of the Government Rolling Mills, Southampton, in order to rejoin his firm, Messrs. Kennedy and Donkin, consulting engineers. Mr. Kennedy was primarily engaged as chief engineer on the construction of the factory mentioned, and its power-house—the work being carried out by direct labour; subsequently, when the factory had been working some months, he was appointed superintendent.

and can easily be proved, assuming a slight knowledge of the principles of elementary trigonometry.

Let us consider a standard, straight-sided rack with sharp corners, in mesh with its pinion (Fig. 1). The possible line of approach contact of the two extends to the point of tangency of this line with the base circle of the pinion. If the possible line of action of the rack extends farther than that of the pinion there will be interference and its consequent undercutting. From this it follows that the interference limit will be reached when the point of tangency T lies on the addendum line of the rack—*i.e.*, T lies on A^1A^1. This will occur at a limit calculated as follows:—

Now the angle $\widehat{MTP}$ can be seen to be equal to angle $\widehat{TOP}$ which is the pressure angle of the gear system, denoted by β.

Again $\frac{MP}{TP} = \sin\beta \quad \therefore MP = TP \sin\beta$.

Letting the pitch radius of the pinion be $R = \frac{D}{2}$

Then $\frac{TP}{R} = \sin\beta$ and $TP = R\sin\beta$ whence $MP = R\sin^2\beta$.

At the interference limit MP = rack addendum 'a.'

Hence $MP = a = R\sin^2\beta = \frac{D}{2}\sin^2\beta$.

But $D = \frac{N}{DP}$ where N is the number of teeth of the pinion, and DP is the diametral pitch.

and therefore $a = \frac{N}{2\,DP}\sin^2\beta$,

giving by transposition

Minimum number of teeth without interference $\Big\}$ $$N = \frac{2\,a\,DP}{\sin^2\beta} \qquad (1)$$

In terms of the circular pitch of the teeth.

$$N = \frac{2a\,\pi}{CP\sin^2\beta} \qquad (1A)$$

These formulæ are perfectly general for finding the interference limits of an involute rack and pinion for any system of heights and pressure angles.

If we wish to find the particular values of the limit for the Brown and Sharpe system, 14° 29′ $\left[\sin^{-1}\frac{1}{4}\right.$ to be correct$\left.\right]$ we substitute the figures.

$$\text{Addendum } a = \frac{1}{DP} = \cdot 3183'' \times CP$$

$$\sin\beta = \tfrac{1}{4} \qquad \sin^2\beta = \tfrac{1}{16}$$

$$\therefore N_{\text{min.}} = \frac{2\,a\,DP}{\sin^2\beta} = \frac{2\,\frac{1}{DP}\times DP}{\frac{1}{16}} = 32 \text{ teeth.} \qquad (2)$$

This can be checked by the other formula (1A).

For other systems of involute gear proceed in a similar manner.

It would be well to mention here that in generating with a hob interference MAY occur higher than 32 teeth for the Brown and Sharpe system, or its corresponding limit in other systems. The reason for this is that the hob has an addendum length equal to the gear dedendum, and this generates the clearance radius at the root of the teeth. Consequently, the hob has a longer contact line, and will necessitate MP (Fig. 1) being longer than the rack addendum itself. The limit is found by substituting dedendum value d in place of a in formulæ 1 and 1A, giving:—

$$N = \frac{2 \times d \times DP}{\sin^2\beta} \qquad (3)$$

$$N = \frac{2\,d\,\pi}{CP \times \sin^2\beta} \qquad (3A)$$

Evaluating for the B. and S. system where $d = \frac{1\cdot 157}{DP}$ we

$$\text{get minimum } N = \frac{2 \times \frac{1\cdot 157}{DP} \times DP}{\frac{1}{16}}$$

$$= 2\cdot 314 \times 16 = 37\cdot 3 \text{ teeth} \qquad (4)$$

In practice, this limit is only reached in a very few cases of gear generation (chiefly in bevels) where the tool has sharp, unrounded corners. If the correct radius is put on the hob tooth, the effect is much diminished, and consequently the undercut is not noticeable above about 30 teeth in the Brown and Sharpe system. This, of course, is for generated gears only. If former cutters are used, then the tooth-curve system has to be a modified involute, as a rotary cutter system cannot produce undercut (necessary for theoretical meshing). The modification alters the quality of running at varying centres, and hence these remarks do not apply to the former cutting system, but to the generating system.

(*To be continued.*)

USE OF OIL FUEL IN THE FOUNDRY IN URGENT EXCEPTIONAL CIRCUMSTANCES.*

By Captain A. E. Plant, A.S.C., Member (On Active Service).

In the summer of 1915 the first foundry in connection with repair shops was started, owing to the difficulty and delay in obtaining castings in gun-metal and aluminium from local French firms. It began in a very small way. There was one pit furnace, natural draught, about 20 in. by 20 in., built of firebrick, and a metal smoke stack 30 ft. high. The foundry consisted of a corrugated iron shed about 25 ft. by 25 ft. The sand was obtained from a pit about 12 miles away, and some old burnt sand carted from a neighbouring foundry was mixed with it to form the floor. One moulder and a foundry labourer were discovered amongst the men engaged on repairs to car and lorry chassis, and they were installed. From time to time there were also found and installed men who were moulders before the war, and had joined as infantry or drivers.

The only source of supply for metals was the scrap-heap, no new metal being obtainable at that time. All the brass and gun-metal borings that had been accumulated from the machine shop were cleaned by hand magnets, and melted in a 150-lb. crucible and run into ingots. The scrap aluminium had to be broken up and melted in a similar manner. As the practice was to run all scrap metal into ingots and

* Paper read at a meeting of the Institute of Metals.

add a certain amount of scrap copper when found necessary, the process was exceedingly slow, and some means of dealing more rapidly with the remelting of scrap was required.

"Charlier" Oil Furnace.

Finally, it was decided to instal a "Charlier" oil furnace, and one wth a capacity of 5 cwt. was bought locally and installed. The fuel recommended was a tar oil, which was obtainable at about 30 francs a barrel. There was no burner on this furnace; a $\frac{1}{4}$-in. gas pipe, led along the top of the air-blast pipe, was bent over at right-angles at the end, and was connected to a receiver; this, in turn, being connected to an oil tank mounted on a platform about 12 ft. from the ground. The oil issued in a thin stream at the end of the blast-pipe, and the force of the blast converted it into a spray. It was regulated in the usual way, and, as most members will be familiar with this type of furnace, a fuller description is unnecessary. The air-blast showed a pressure of $9\frac{1}{2}$ in. (water-gauge).

Before going any further, it must be stated that when the demand for the next supply of this tar oil was made, the vendors put up the price very considerably. In facing this problem it struck the writer that it might be possible to utilise a considerable quantity of waste oil and grease that had accumulated from the cleaning out of the engines and gear-boxes of cars and lorries that were undergoing repairs in the depôt, As the consistency of this waste oil varied very considerably in the various drums in which it was stored, it was decided to obtain a large 600-gallon tank that was lying on the premises and to put in all the waste oil to settle. The tank was circular and divided into two compartments with a drain-cock at the bottom of each, for draining off water and dirt. Some small holes were drilled in the dividing plate above the centre line in order that the lighter oil could flow from the first compartment into the second. All the waste oil was poured into the first compartment through a wire-gauze filter of about 1-16th inch mesh. The oil was always drawn off from the top of the second tank, and then passed through a piece of canvas in order to clean it still further from dirt and foreign matter, and it was then emptied into the supply tank about 6 ft. above the furnace level. This oil was found quite easy to use. In fact, it gave better results than did the tar oil, and, for over two and a half years, nothing else but waste oil has been used here. One of the first troubles encountered was due to the fact that on cold days in the winter oil flowed very sluggishly in the pipes, and a very irregular flame resulted in the furnace.

To overcome this, a small metal receiver was fitted as near to the furnace as was possible. This answered several purposes. Firstly, it could be quickly and easily warmed with a blow-lamp. Secondly, it acted as a final trap to catch the dirt and foreign matter in the oil, and so prevented the end of the oil supply pipe in the furnace from being blocked. Thirdly, it acted as a reservoir and supplied oil during such short periods as the oil flowed sluggishly in the supply pipe, and thus a steady flame was obtained. The oil consumption with a charge of 350 lb. heavy gun-metal scrap, which was the usual charge, averaged about $9\frac{1}{2}$ gallons, and the time taken (furnace being hot to commence) one hour. This consumption is not very economical, perhaps, as it was not always possible to have the same operator at work, and the operators (soldiers) had never had any previous experience of this class of furnace. The makers assured us that one could easily melt iron for producing castings, but the furnace did not attain a sufficiently high temperature to do this satisfactorily. When it was attempted, great quantities of slag were produced, and the castings were exceedingly hard and brittle. The metal often attained too low a temperature to run freely. This furnace is chiefly used for running down gun-metal borings from the machine shop, and gun-metal and brass scrap; all metal, either new mixings or scrap, being first run into ingots.

It is necessary to use plenty of flux to protect the surface of the molten metal from absorbing gases. We do not often cast direct into the mould, but remelt ingots in a crucible in a vertical oil-fired furnace. For melting metal for aluminium castings the furnace is most satisfactory, as the temperature can easily be controlled, and we have had great success with it for the latter work.

Vertical Oil-Fired Furnace.

It was decided to build a vertical furnace to take up to 100-lb. crucibles, and to use the same waste oil as fuel. The reasons in favour of installing this type were as follows. The coke obtainable was often small and of poor quality, consequently the time required for melting was excessive, and there was, under these conditions, a great tendency for there to be absorption of gas in the metal. Secondly, there was a great saving of time in melting, and there was less chance of the metal absorbing injurious gases.

The furnace was circular in design, the casing being made of cast iron and the lining of fire-bricks. The blast-pipe had a jet of $1\frac{1}{8}$ in. diameter connected to it, and the jet entered the furnace at such an angle that the issuing flame struck the furnace wall at a tangent, and a whirling motion was imparted. The vaporised oil entered the furnace just below the centre of the crucible (not the bottom). The blast-pipe was itself $2\frac{7}{8}$ in. diameter. Flames and hot waste gases, which exhausted through an opening at the bottom of the furnace, impinged directly on it, so that the blast entered the furnace at a high temperature. The fuel entered the blast-pipe through a $\frac{3}{8}$-in. steel pipe, just above the place where the hot exhaust gases struck it. Directly in front of the heated portion of the blast-pipe was a cast-iron baffle plate, which deflected the flow of exhaust gases upwards and gave the blast-pipe in front of it the full benefit of all the waste heat. The fuel oil was contained in a 15-gallon tank fitted with a hand air-pump and a pressure gauge. About 5 lb. of pressure was kept up. In between the fuel tank and the entrance of the oil to the blast-pipe a brass receiver was fitted in order to fulfil two purposes. Firstly, it was easily heated by a blow-lamp on very cold days to make the oil run freely for starting up. Secondly, it regulated the supply of oil to the blast-pipe in case the oil flow from fuel tank was a little sluggish, as it often is when very cold. Thirdly, it acted as a final trap to catch any dirt or foreign matter in the fuel oil. Between the receiver and the

fuel lead pipe to the furnace a small regulating cock was fitted. The pressure of air used was 9 in. (water-gauge). An electric motor driving a fan at 3,000 revolutions per minute was the source from which the air supply was derived. A fire-brick cover closed the top of the furnace and had a small aperture in the centre for charging and inspection.

The melting times varied somewhat, owing to the variation in the temperature and quality of the fuel oil, and consequently the consumption was not constant. An average time to melt 80-lb. gun-metal ingots was 40 minutes, after the furnace had been heated up. When melting aluminium ingot an 80lb. crucible took about 15 minutes, the furnace being hot initially.

Nothing wonderful is claimed either in oil consumption or time taken in melting, but it will probably be of interest, in so far as it shows how it is possible to adapt surrounding circumstances to one's needs by utilising waste substances and in devising and constructing suitable apparatus to suit the needs of a foundry in the B.E.F.

The essential points to watch in the use of waste oil are—freedom from dirt, water, or other foreign matter, and the fact that it must flow freely to the jet.

Castings in iron, gun-metal, phosphor-bronze, brass, and aluminium are produced in the same building, a portion of the floor being reserved for bronze and brass, as it is found that aluminium and iron castings can be successfully made on the same floor. All the scrap-metal used is melted and first run into ingots, also the borings of gun-metal and aluminium from the machine shop. Over a ton a month of new white metal is made for lining and making die-castings for petrol engine bearings. The monthly average weight of castings produced varies from 5 to 8 tons, and the castings number from 1,600 to 2,500, being very varied in character and weighing from a pound to nearly a ton, according to the demands. Owing to the variation in quality of pig iron, scrap metal, and of fuel, many problems present themselves from time to time.

These notes are offered purely as a matter of general interest to show what can be done by one branch of the B.E.F. in availing themselves of the chance of producing new parts from scrap and waste material on the spot.

The two cupolas, fans, sand-mill, furnaces, with the exception of the "Charlier" oil furnace, have been made on the premises out of scrap material.

A few examples of the class of work turned out which are given below will indicate its varied nature:—

Bushes in gun-metal, cast-iron Daimler water-jacketed cylinder heads, cast-iron water-jacketed induction pipes, aluminium pistons, cast-iron piston ring blocks. All kinds of bearings, brackets, pipes, and flanges in all metals. Shop tools and jigs. Tables for hydraulic pressures (average weight, 18 cwt.). Aluminium pulley wheels, parts of radiators. Many more different kinds of castings are made, but this gives a fair idea of the work produced.

It is quite clear that by using materials on hand for the production of certain parts on the spot for chassis that have become superseded since the war, a very considerable saving in time on repairs can be effected.

THE WORK AND INFLUENCE OF JOULE.

An ordinary meeting of the Manchester Literary and Philosophical Society was held on January 7th, 1919, the President, Mr. William Thomson, F.R.S.E., F.I.C., F.C.S., in the chair. Professor Sir E. Rutherford, M.A., D.Sc., F.R.S., gave an account of "The Work and Influence of Joule."

At the outset, the lecturer stated that the Society had hoped to secure on this occasion an address from a distinguished member of the Society who had known Joule well, personally. Unfortunately, this had not proved possible, and he had been asked at very short notice to fill the gap. In the short time available, it was impossible to review the great series of researches made by Joule during his long and busy life, but attention would be confined to the first five years (1838-43) of Joule's scientific career, which began at the age of nineteen, and an endeavour would be made to trace during this period the gradual growth of Joule's power of experimentation and of philosophic insight. In this, he had been greatly assisted by the able memoir on the work of Joule published by the late Professor Osborne Reynolds in the Memoirs of the Society.

This period was in some respects the most fruitful and inspiring in Joule's lifetime, for it included his remarkable researches on the transformations of energy in the voltaic cell, the dynamo and motor, and his first measurement of the mechanical equivalent of heat.

An Account of Joule's Researches.

A brief account was at first given of Joule's researches to improve the electromagnetic engine for the generation of power and of his investigations in electromagnetism. These investigations had an important bearing on his later work, for his electromagnetic engine, used both as a dynamo and motor, was an indispensable adjunct in his later researches, while the familiarity he had gained in the accurate measurement of the work done by his engine proved later of great value.

At this stage Joule had appreciated the great importance of accurate measurement of his electrical and mechanical magnitudes. He had designed a special galvanometer for measurement of current in terms of the voltameter of Faraday and adopted definite standards of resistance. It was the use of these standards that made possible his later far-reaching deductions.

Heating the Electric Current.

After completing his work on the electromagnetic engine, Joule attacked the problem of the laws of heating of the electric current and proved for the first time that the heating effect was proportional to the square of the current. In this research, he investigated the heat emission in electrolytes as well as in conductors, and this led to a series of researches in which he traced the various factors to be taken into account to evaluate accurately the energy emitted in an electrolytic cell. He then proceeded to determine the total heat emitted by his voltaic battery for the consumption of 1 lb. of zinc and compared it with the heat developed by the combustion of 1 lb. of zinc in oxygen. After surmounting numerous difficulties, he was able to show conclu-

sively the remarkable fact that the chemical heat of combination was equal to the heat developed by the same chemical change through the intermediary of the voltaic battery. At this early stage, he had thus proved the equality and convertibility of chemical, electric, and heat energy, and had laid the experimental foundation for the great subsequent generalisation of the conservation of energy.

It is clear, however, that at this time Joule did not appreciate the full significance of his results, but was inclined to consider them as a proof of an electric theory of Davy and Berzelius, viz., that the chemical heat of combination was a direct consequence of the combination of charged atoms. It was not until some time later that he modified this view and began to appreciate the underlying relation between these different forms of energy.

Joule's Electro-Magnetic Engine.

Then followed his research to prove the electric current generated by his electro-magnetic engine obeyed the same laws of heating as the voltaic current, and his direct measurement of the heating effect produced by the magneto-electric current by the expenditure of a measured amount of work. This gave him for the first time an approximate measure of J — the mechanical equivalent of heat, and he was able to verify the relations between heat and work when his electro-magnetic engine, acting either as a dynamo or motor, was placed in a battery circuit.

A brief reference was made to his subsequent elaborate investigations to determine the mechanical equivalent of heat by the compression of gases and by friction.

Joule's Remarkable Experimental Power.

The lecturer drew attention to the remarkable experimental power exhibited by Joule in these early researches, and the refined methods he had introduced for the accurate measurement of current, heat, and work. Few men, at the age of twenty-five, have exhibited such powers of accurate measurement and ability to overcome experimental difficulties, or have shown such a record of masterly pioneer researches.

A brief discussion was given of the reasons why the full recognition of the fundamental importance of Joule's earlier researches was so long delayed and of the difficulties experienced by Lord Kelvin in reconciling Joule's conclusions with the work of Carnot on "Heat Engines." Adjustment of views on both sides was necessary before the foundations of the new science of thermodynamics were securely laid, and before the great principle of the conservation of energy was generally recognised.

Professor Haldane Gee exhibited and described some of the apparatus used by Joule in his researches. These included his first electromagnetic machine, parts of his later engines, an electro-magnet of great lifting power, a reading microscope used for the calibration of delicate thermometers, and a tangent galvanometer. Lantern slides of larger pieces of apparatus preserved in Manchester were shown. Special reference was made to the entries in Joule's laboratory note-books dealing with the discovery of the law of electric heating and the many thousands of measurements connected with the mechanical equivalent of heat. Included with the manuscripts and other Joule memorials that have been collected is a letter from James Clerk Maxwell expressing the following opinion of the labours of Joule:—"There are only a very few men who have stood in a similar position and who have been urged by the love of some truth, which they were confident was to be found, though its form was as yet undefined, to devote themselves to minute observations and patient manual and mental toil in order to bring their thoughts into exact accordance with things as they are."

CHIMNEY STACKS.

By James Claughton.

(Continued from page 132.)

Modern Steam Boiler Practice.

A short, comprehensive survey of modern steam boiler practice is necessary to complete any treatise on chimney design. The actual performance of any single steam boiler plays an important part in the final deductions for fixing up the dimensions of the chimney, in order that the chimney shall be designed equal to the work that is required of it. In the general interests of the entire plant, it is of equal importance that the chimney stack should be economically designed. The manufacturer attaches great importance to the economical design of the visible units of the steam plant, but very often fails to consider such items as boiler settings, flue passages, damper chambers, and chimney stacks, seriously, as regards their individual effect upon the economical operation of the entire plant. The latter facts will be patent to those who have had the opportunity of inspecting various steam-raising plants erected in this country. Perhaps it is this difference of opinion, or, shall we say the neglect of the importance of the part played by the invisible secondary units, that has been responsible for the comparatively recent revival of the subject of boiler efficiency. Many of us, the younger generation of engineers, thought this subject had been fully thrashed out years ago, but recently much has been written calling for further steam-boiler efficiency. The actual efficiency of steam boilers always was, and always will be, a very controversial subject. Under the general title of the scientific management of steam-raising plants, many writers have contributed to the various technical journals much useful information on this important subject. Unfortunately, however, the influence exerted by the chimney appears to have been entirely overlooked. This synopsis is not intended to be a general treatise on steam boilers, and is given solely to enable the connection that exists between the steam boiler and the chimney to be more readily understood.

The information given is the result of a careful study of numerous tests that have been carried out in various parts of the country by many of the leading manufacturers of steam-raising plant. The actual figures quoted may be relied upon as being fully representative regarding modern steam-boiler practice, and from this standpoint the accuracy of the figures given cannot be questioned.

At the present time, in the majority of power-plant installations, the steam boiler plays one of the most important parts, because its prime function is to

convert the heat energy of the fuel, by means of water, into steam, for use in the steam-driven engine or turbine. The steam boiler is, then, a vital part of the plant, the successful operation of which depends almost entirely upon the actual performance of the steam boiler. To improve the efficiency of the steam boiler is to improve the efficiency of the entire plant. In this direction, the value of a correctly-designed chimney can be shown to assist, in no small way, the general efficiency of a steam plant installation.

The author has previously stated that a survey of the site, and a consideration of local conditions is advisable. In the latter the probable source of fuel supply should be carefully noted. In view of the foregoing statement, it follows that it is often advisable, when possible, to carry out a practical test on a neighbouring plant of a type similar to that which it has been decided to instal in the projected new plant.

These preliminary tests can generally be easily arranged; in fact, many proprietors are only too pleased to have their plant tested. The information obtained from these preliminary tests can be used to advantage in the general design and layout of the new plant. Further, it is often possible to prevent certain troubles occurring on old plant from recurring on the new projected plant. This item in itself should fully justify the method of procedure suggested.

For our particular purpose, in any test on the actual performance of a steam boiler, the two chief items to note are the quantity of water evaporated and the amount of coal consumed per hour. The former is necessary to compute the power developed by the engine, and the latter is the determining factor for fixing up the size of the chimney required.

Later, several typical examples of actual tests on various types of steam boilers are given. In this series it will be possible to consider the effect of using mechanical stokers; also the difference caused by the adoption of artificial draught, compared with hand-fired furnaces. With reference to the application of artificial draught, the author is convinced that this system should only be employed when the natural draught is low, *i.e.*, when a low chimney, say under 100 feet in height, is used. In any single case, the question must be answered by the conditions prevailing at the site. From a careful survey of the results of these tests it is safe to state that, generally speaking, the best results are obtained where mechanical stokers are used. This might be expected because the rate of fuel fed into the furnace is constant and uniform. Further, the quantity of air required for complete combustion is under control and can be regulated to suit. The practical result of the foregoing is that no black smoke is emitted from the chimney-stack. From past experience, and in view of recent developments in machine stokers, the writer is of opinion that the general tendency in the future will be towards lesser grate areas, smaller diameter furnaces and boiler flues, longer boiler flues, and a higher gas velocity through the fires, and along the boiler flues. This would appear to be especially advantageous when compressed air is introduced into the furnace. When the whole system is under direct control it naturally follows that the theoretical results desired are more likely to be obtained than when promiscuous methods, which depend entirely on the human factor, are employed. Thus, an engineer, when designing or setting out a new plant, can almost determine beforehand the various factors and outputs that will be obtained at various points of the installation. This fact, in itself, is highly gratifying, inasmuch as it gives to the engineer responsible full control of the plant, and enables him at all times to readily ascertain whether the installation is keeping up to its duty.

(To be continued).

ENGINEERING LAY-OUT ARRANGEMENTS AND TENDER DRAWINGS.

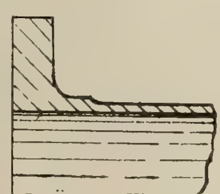
By Douglas Wilson, A.M.I.Mech.E.

(Continued from page 134.)

Steam Pipe Flanges.

There are three methods of attaching flanges to steam pipes, and all are commonly adopted. These are the welded, riveted on, and screwed and expanded types, examples being shown respectively at Figs. 46, 47, and 48.

Where prime cost is not the first consideration,



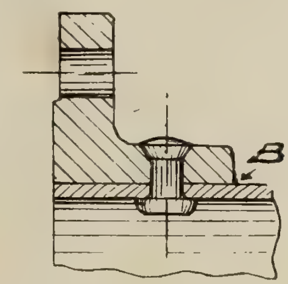
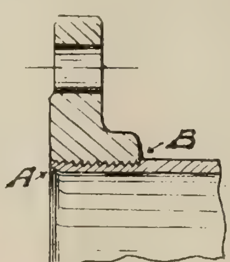


Fig. 46. Engineering Lay-out. Fig. 47.

the welded flange is undoubtedly to be recommended for all sizes up to and including 10 in., in preference to screwed or riveted, especially if superheated steam is used.

The welded flange is shown at Fig. 46, and, as will be seen, has a strengthening shoulder at the root



Engineering Lay-out.—Fig. 48.

of the flange. It is safe for all high steam pressures with superheat.

The riveted-on flange comes next as regards efficiency, and for sizes over 10-in. bore is suitable for all pressures. The cost above this size is about the same as the welded flange. For pipes over 12 in. bore, they are recommended in place of the welded

type, as above this size the latter does not show any marked efficiency.

The riveted flange is shown at Fig. 47, and is generally used on pipes having a bore of not less than 6 in. Below this size the screwed flange is employed, see Fig. 48. This flange is fixed by means of fine screw threads, and afterwards expanded by a tube expander, riveted over the face at A and caulked at B, the face and edge being then machined. This flange is suitable for pressures up to 120 lbs. per square inch without superheat, from 6 in. to 10 in. bore, and up to 150 lbs. below this size.

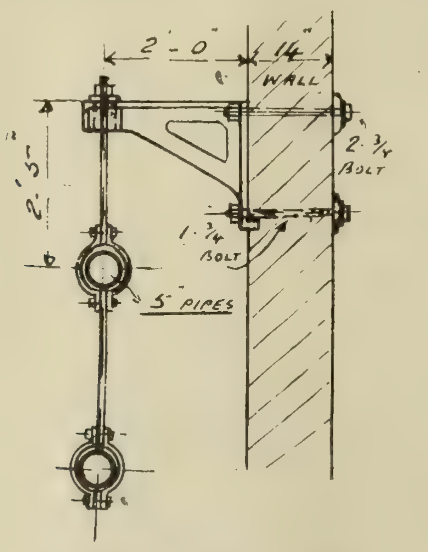
The riveted flange will also require caulking at B, after it has been shrunk on the pipe, and then machined. Facing strips are generally provided for on the flanges of the types shown in Figs. 47 and 48 for making the joint when corrugated metal joints are used.

These two flanges should always be specified wrought steel, pressed out of the solid. The drilling for all flanges should be to British standard, now worked to almost universally.

There are several methods of making the joints steam-tight, and engineers have their own particular prejudices and likings for certain types.

For very high pressures, say, over 220 lbs. per square inch, scraped surfaces seem to be favoured for pipes up to about 8-in. bore. Below this pressure it is usual to use "copperite" or woodite rings, the flanges being faced fully across.

Yellow metal corrugated joint rings are also largely used for high pressures. These rings, before being applied, should be smeared with a thin coat of graphite or red lead and boiled oil. When these rings are adopted, the flanges must be provided with facing strips, as previously stated, because the flange bolts do not pass through the rings. Asbestos paper



Engineering Lay-Out.—Fig. 19.

well graphited makes a good joint for moderate pressures and temperatures, the pipe flanges being faced fully across.

Corrugated joint rings must not be re-used after the pipes are pulled apart; new ones must be inserted.

Pipe Supports.

Steam mains can be suspended from above, or supported by columns or wall brackets, whichever method is most suitable to the arrangement of building, etc.

Fig. 49 shows the general method of suspending the pipes from a wall bracket or beam. This offers no resistance to expansion of the main, and is a

Fig. 50.

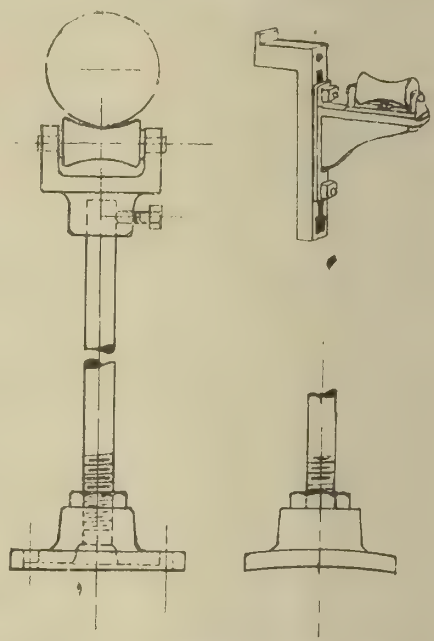


Fig. 51. Engineering Lay-Out. Fig. 52.

very simple arrangement. Fig. 50 illustrates an adjustable roller bracket suitable for building in and bolting to a wall. The roller can be adjusted to conform with the pipe alignment after the bracket has been built in.

Fig. 51 shows a column support, arranged for easily adjusting the height, whilst Fig. 52 indicates the cast-iron base curved when the column is required to stand on the boiler drum.

As mentioned earlier, pipes do not vibrate or swing so readily when they are supported on rollers or brackets. Rollers should be inspected and oiled frequently, as, should they stick, they are liable to wear the pipe.

Pipe Covering.

The efficient lagging of steam pipes is most necessary for the prevention of excessive condensation, and a good deal might be written on this important question. Numerous calculations have been made by makers of insulating material as to the exact amount of heat lost by uncovered pipes, and the most suitable composition, etc. These will be found in most of their catalogues, so the writer does not intend to go into any figures regarding the money saved per annum, etc., by using covering. It may, however, be stated that a first-class lagging, well applied, will save 80 to 90 per cent of the heat which would be radiated from a naked pipe. This obviously means a very great saving in the coal bill.

The choice of a covering must not be governed by the conductivity of the material alone, as other qualifications are necessary, the chief being the resistance to taking fire. Materials such as hair or wool

felt, which stand very high in the list of good non-conductors, are liable to become charred and sometimes to get on fire. Silicate cotton or slag wool seems to be the best non-combustible covering, and the air space is very small and split up, which adds to its good insulating qualities.

(To be continued.)

Trade Items, Notes, &c.

It is announced that Messrs. Laminated Gears Limited will shortly commence the erection of a new machine shop at their Sedgley Road works, Sheffield, which, when finished, will, it is anticipated, enable them to double their present output.

The largest boiler head ever made from a single plate has just been made in the United States. It is 13 ft. in diameter and is $1\,^3/_{16}$ in. thick. A specially-constructed car was necessary to take it from the Lukens Steel Company, where it was made, to the yards of the Portland Shipbuilding Company.

The Electricity Committee of Glasgow Corporation has recommended the acceptance of the offer of Messrs. Babcock and Wilcox Ltd. to supply equipment for the second boiler-house at the new generating station at Dalmarnock, at the same price at which they provided similar equipment for the first boiler-house there, viz., £140,282.

The first concrete ship built in Ireland has just been most successfully launched from the yard of Messrs. J. and R. Thompson Ltd., of Belfast and Dublin. The vessel is one of several sea-going barges and steam tugs under construction on the Mouchel-Hennebique system of ferro-concrete for the Ministry of Shipping.

It is announced that the Electric Welding Committee of the Shipping Board Emergency Fleet Corporation has decided to recommend the construction of a 9,300 tons deadweight vessel to be built by electric welding. In addition, it is stated that the midship section of a 9,600-ton vessel, to be launched by the Federal Shipbuilding Corporation at Kearney, New Jersey, U.S.A., is to be electrically welded.

A Mallet locomotive, with a weight of 535,000 lb. without tender or 747,000 lb. with tender has been built for the Norfolk and Western Railway. There are eight drivers on a side, with a total driving-wheel base of 57 ft. 4 in. The weight on the drivers is 472,000 lb. The weights on the leading truck and trailing truck are respectively 28,000 and 35,000 lb. The total wheel base is 92 ft. $11\frac{1}{4}$ in. The tender, which weighs 212,000 lb., has a water capacity of 12,000 gallons and a coal capacity of 20 tons.

In connection with the re-issue of the quarterly returns of merchant shipbuilding made by Lloyd's Register of Shipping, it is interesting to note the position taken by the Clyde yards. During the quarter ending September 30th, there were under construction in the United Kingdom 383 merchant vessels of a gross tonnage of 1,746,953. Of these, 78 vessels were being built in Glasgow and 50 in Greenock, the former responsible for 331,008 tons, the latter for 271,080 tons. These figures, of course, do not include any Admiralty work.

An interesting review of the work carried on during the year by the Mersey Docks and Harbour Board was given at the last meeting of that authority by Sir Helenus Robertson, the chairman. He pointed out that the difficulties which, during the war, had delayed the progress of new works of any magnitude, had remained with them to a marked degree in the past year, except as regarded certain works specially sanctioned by the Government as being works of national importance. Special attention has been paid during the year to mechanical appliances for facilitating the rapid handling of cargoes on the dock quays, and further electrically-driven appliances, as well as a large number of steam cranes, have been supplied, which it was hoped would materially help them to keep the quays clear. Schemes for the distribution of electrical energy to be supplied by the Corporation had been sanctioned and were being pushed forward. The Board had also authorised the adoption of a comprehensive scheme for the electrification of the dock estate from the Sandon to the Hornby Docks, with the view to the extended introduction of electrically-worked mechanical appliances on the dock quays, etc., at a total estimated cost of £123,900.

The Danish Landthing has introduced a Bill for utilising the water power of the river Gudenne, in Jutland, for the generation of electrical energy. It is stated that by building an earth embankment across the river valley, at a point where there is a deep bed of firm clay, it is possible to form a lake of about 1,400 acres, which will act as a regulating reservoir for the power station; further, by deepening the river below the dam, an average fall of 27.8 feet can be obtained. The quantity of water fluctuates very much, and it is proposed to instal machinery for utilising the maximum quantity of water—viz., 4,500 H.P. or 3,000 kw., but the average daily output will only be about 1,140 kw. The total annual output is estimated at about 11,000,000 kw. hours. The current will be generated at a pressure of 10,000 volts and passed through a step-up transformer to 50,000 volts for transmission, finally being stepped down locally to the voltage required. The longest transmission line will be about 40 miles. The total cost is estimated at about £300,000 for the power-station, including three turbines each of 1,800 H.P. It is hoped that the works will be completed and ready to start work in the autumn of 1919.

Gas and Electricity (Variation in Conversion Equivalents).—(1) The Controller of Coal Mines, in exercise of the powers conferred upon him under Clause 7 of the above Order, hereby gives notice that the conversion equivalent for gas in terms of fuel shall be increased to 18,750 cubic feet to the ton, and for electricity to 1,000 Board of Trade units to the ton, as from the meter readings taken for the close of the quarter ending December 31st last (except in those cases in which a higher conversion equivalent has already been specially agreed). (2) Further, the Controller of Coal Mines determines that the allowances for lighting under Clause 8, or the special assessments for lighting agreed under Clause 12 of the above Order shall from such meter readings be likewise increased by 25 per cent. (3) Such variation in the conversion equivalent for lighting allowances shall be without prejudice to any action taken or to be taken in connection with excess consumptions of gas or electricity in the quarter just closed. (4) Further, under the powers conferred upon him by Clause 4 of the above Order, the Controller of Coal Mines agrees to the suspension of Clause 99 referring to the restrictions on gas and electrical fittings as from the date of this notice.

As rapid analyses of white metal are frequently needed, the following note on the subject, due to Dr. Paul Drawe ("Zeitschrift für Angewandte Chemie," April 30th, 1915), may be of interest, though there is little novelty about the various proposed determinations. About 1 gram of the metal borings is dissolved in 10 cub. cm. of nitric acid of density 1.4, the solution is diluted with 50 or 100 cub. cm. of hot water, boiled for five minutes, and then filtered. The moist precipitate (consisting of oxides of tin and antimony) is washed into an Erlenmeyer flask, heated and diluted with water; about 2 grams of pure powered iron are then dropped into the flask, and the liquid is kept at 80 deg. Cen. for about an hour, air being excluded; the tin will then have been dissolved as stannous chloride (which is titrated with iron chloride, no indicator being needed), while the antimony is precipitated as metal on the excess of iron, which is extracted with hydrochloric acid. The original filtrate contains the lead, copper, iron, and zinc of the white metal. Sulphuric acid is added to the solution, which is evaporated to dryness and redissolved in water; the lead remains insoluble as sulphate, the other metals pass into solution. Copper is first precipitated by sulphuretted hydrogen; the iron is then oxidised with bromine water and precipitated as hydro-oxide by caustic soda, and the zinc is finally precipitated from the filtrate, previously acidified with hydrochloric acid, by soda.

The Institution of Civil Engineers.—An ordinary meeting of the Institution will be held on Tuesday, February 11th, at 5-30 p.m., when the paper to be further discussed is "Centrifugal Pumps for Dealing with Liquids containing Solid, Fibrous and Erosive Matters," by the Hon. Richard Clere Parsons, M.A., M.Inst.C.E. On the conclusion of this discussion the following papers will be presented for discussion: "The Flow of Water in Pipes and Pressure Tunnels," by Frederick John Mallett, Assoc.M.Inst.C.E.; and "Discharge of Large Cast-Iron Pipe Lines in Relation to their Age," by Alfred Atkinson Barnes, Assoc.M.Inst.C.E.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.

Altrincham Sub-Branch.

The second paper of the session was read before the members of the above Branch on January 22nd, in the Central Liberal Rooms, Altrincham, by Mr. W. E. Bennison, A.M.Inst.M.E., the subject being "Cams." Mr. Gayter, District chairman, opened the meeting with a few appropriate remarks, pointing out that Mr. Bennison was one of our own members, and very well known in the district.

Mr. Bennison then read a most excellent paper on the important subject of cams, first describing the general functions of the cam, and then illustrating by very clear diagrams the general types. After describing these Mr. Bennison proceeded to show the methods of plotting out the "cam curves" necessary for the various motions of the "followers," and these he demonstrated with great ability. The graphic value of his diagrams rendered also the whole *modus operandi* quite clear, and the members present were greatly interested from beginning to end.

So little, if any, information on cams is to be found in textbooks that we would like to see Mr. Bennison's valuable work in book form, as it would fill a long-felt want for draughtsmen.

Mr. Gayter heartily thanked Mr. Bennison for his splendid paper on behalf of the Association of Engineering and Shipbuilding Draughtsmen, and then declared the meeting open for discussion.

Mr. Ingham proposed a hearty vote of thanks to Mr. Bennison, which was seconded by Mr. Bartley, and vigorously responded to by the members.

The next lecture will be given at the Central Liberal Rooms, Altrincham, on February 26th, the subject being "Sand Blasting," by Mr. R. G. Ankers.

Douglas Wilson, A.M.Inst.M.E.,
District Tech. Sec.,

Brier Cottage, Arthog Road,
Hale, Altrincham.

Letters to the Editor.

The Editor will always be pleased to hear from readers who desire to express their opinions upon engineering and kindred subjects. Letters should be as brief as possible and be written upon one side of the paper only. The insertion of a letter in our columns does not necessarily mean that we endorse the opinions expressed therein.

EXCESS PROFITS AND INVENTIONS.

To the Editor of "The Industrial Engineer."

Sir,—The letter of Mr. A. A. Thornton in your issue of January 22nd as to the effect of excess-profits duty on the organised development of scientific invention and new initiative in business raises a very serious question, and one which I consider ought to be taken up at once by the professional and commercial institutions with a view to some alterations of the law in the next Finance Act. In the course of my professional duties I find that many persons spending money on the development of inventions are still not aware of the probable effect of the excess-profits duty on the profits resulting from the dealing with patents, and I have recently heard of a case where a limited syndicate (formed expressly to acquire, develop, and deal with an invention) had actually sold the patent rights in its invention for a Continental country, and was proposing to deal with the proceeds without a thought that the Inland Revenue may, at the end of an accounting period, claim nearly 80 per cent of the sale proceeds on the ground that they are profits of a business or "a gain in an operation of business in carrying out a scheme of profit-making" (to quote from a well-known tax case). The Commissioners are judges of facts, and as their consideration of cases is "in camera," it follows that it is only on rare occasions that actual examples showing the way tax provisions apply in practice are given public prominence. To show the damaging effect on the development of new British industry of the uncertainties as to how the Commissioners will view the facts, may I quote as examples of many cases the position of two which I have had under my personal notice?

(*a*) A private company was recently formed to acquire and deal with a patented chemical process—admittedly of national importance in its bearing on a "key" industry hitherto almost a monopoly of Germany. Interested people in the City were willing to put up the required capital, and a lease of experimental and manufacturing works was actually negotiated, but meanwhile the investors had their attention called to the fact that if the invention is a success most of the profit will be claimed by the Inland Revenue as being "excess profits." The negotiations were cancelled, and at this time, when the development of new British industries is of such national importance from both the labour and financial standpoint, this effort to capture a German "key" industry is at a standstill. Meanwhile, I am informed that during the war period large quantities of the particular product have been imported from U.S.A. at prices at least double of those at which the British inventor claims he can by his process manufacture the product in England if he is given the required financial assistance.

(*b*) A client of mine was recently asked to assist in financing a company acquiring a new engineering invention, and expressed his willingness to do so if the promoters could satisfy him that, supposing the invention was all it was suggested, the profits would go to those who would have to bear the loss if it should be a failure. The promoters referred the point to their own solicitors and accountants, and then admitted that their advisers agreed that any profits would probably be subject to a heavy claim on behalf of the Government if the Excess Profits Duty provisions remained in force. The financial assistance was refused.

With such uncertainties one must ask how can new ideas be developed and British initiative have a fair chance in the international markets, and how can new businesses be encouraged to absorb the excess labour that demobilisation will provide? Surely any suggestion that this duty should be retained as a more or less permanent feature of national finance must be strongly opposed if its incidence on new business is fully apreciated, and I agree with Mr. Thornton it is the duty of those who can see how heavily the duty bears on new enterprise to make that knowledge public at once.—Yours faithfully,

Francis M. Caporn.

St. Bride's House, London, E.C.4.
January 24th, 1919.

Queries and Replies.

We shall at all times be pleased to help our readers out of their difficulties to the best of our power, and invite them to make use of this column for that purpose.

Query.—Foreman (Hapton) says he is also a draughtsman, and in his capacity has under him various tradesmen, including fitters, smiths, loco. and motor drivers, firemen, etc. He asks if he is compelled to join a trades union belonging to the men. He would prefer to join an engineers' or draughtsmen's union. Answer.—"Foreman" is not compelled to join any men's union. He has quite free choice in the matter. If he requires a trade union body he could join the local branch of the A.S.E. As a draughtsman, he might link up with the Mid-Lancashire Branch of the Association of Engineering and Shipbuilding Draughtsmen.

A. N. (Oldham).—We are always pleased to receive practical articles dealing with general engineering, and further contributions from you will be appreciated.

T. M. (Birmingham).—A further instalment of the article on "Chimney Stacks" appears in the current issue.

W. Jones (Liverpool).—We would advise you to join a branch of the Association of Engineering and Shipbuilding Draughtsmen.

D. Riley (Old Trafford).—We hope to publish your article in our next issue. Regarding your offer, kindly send the matter and we will give it our consideration.

H. Wilson (Wrexham).—Wood may be stained by using nitric acid diluted with ten parts of water. Wash the wood with the solution, and a mahogany colour will be obtained. To produce a rosewood, finish glaze with carmine. Asphaltum, thinned with turpentine, also produces a mahogany colour on new wood.

Patent Applications.

The following Abstracts of Specifications are brought up to the lates date possible, and are abstracted from the Illustrated Officia Journal of Patents, which is published weekly.

ABSTRACTS OF SPECIFICATIONS.

ALLOYS.

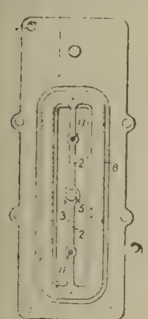
118,947.—BRITISH THOMSON-HOUSTON CO., 83, Cannon Street, London.—(General Electric Co., Schenectady, New York, U.S.A.)—Nov. 20th, 1917.—Aluminium alloys contain about 6 to 12 per cent of zinc, about ½ to 2½ per cent of magnesium, and about 1 to 3 per cent of iron, chromium, cobalt, nickel, titanium, or manganese, or a mixture of these metals, the balance being aluminium. The aluminium is preferably melted first, then the iron, etc., added, then the zinc, and finally the magnesium, and the first stages of the working of the alloy are carried out at about 450 deg. Cen.

CASE-HARDENING.

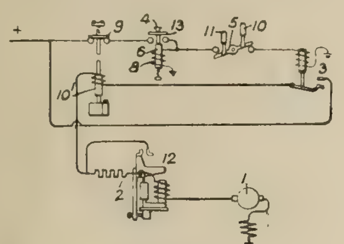
118,983.—A. E. BAMFIELD, 92, Hampton Road, Bristol.—Feb. 18th, 1918.—A mixture consisting of 50 parts of sodium silicate, 25 parts of China-clay, 18¾ parts of amorphous silica, and 7¼ parts of silver sand is applied as a protective coating to parts of articles not to be carburised during the case-hardening process, and is used also to prevent oxidation of the carburised articles during subsequent annealing.

VALVES.

119,008.—O. OHLSSON, 5, Skogsgatan, Södertelje, Sweden.—May 3rd, 1918.—A check valve particularly adapted for use as an air admission valve for an internal-combustion engine and of the type comprising an annular rim supported by radial spring arms has the rim of elongated shape, with the arms connected to the parts farthest distant from the central part or hub. In the form illustrated, the rim is rectangular with rounded corners and has the shorter sides connected by arms 2 with a central part 3 clamped in position by a bolt 5. The arms are provided with holes adapted to engage fixed guide-pins 11 and the rim, which is constructed of stamped steel, has a leather facing 8 riveted to it.



Patent 119,008.



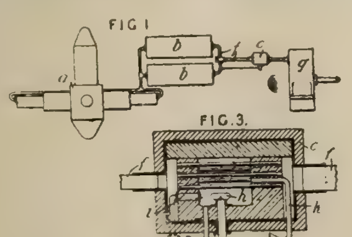
Patent 119,016.

ELECTRIC MOTOR CONTROL.

119,016.—BRITISH THOMSON-HOUSTON CO., 83, Cannon Street, London.—(General Electric Co., Schenectady, New York, U.S.A.)—June 1st, 1918.—The circuit of the motor 1 is closed by the contactor 3, the actuating-circuit of which is completed by the push-button switch 4 after the switch 5 has been closed. The switch 4 is held closed by an electro-magnet 8 which is energised through the contact 13 and acts as a no-volt release. An overload relay 10' controls a contact 9 in the retaining-circuit, and the starting resistance 2 is controlled by the series contactor 12. In a modification, the start-and-stop button switch 5 is replaced by a drum switch.

MOTOR POWER PLANT.

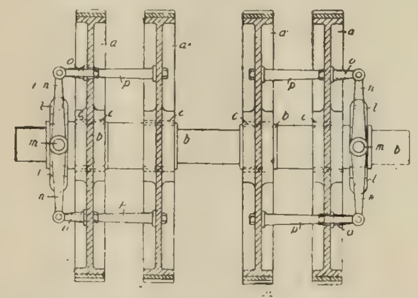
119,046.—C. D. DOUGLAS, Shirley, Beechcroft Road, Watford, Hertfordshire.—July 17th, 1917.—A motor installation particularly applicable to aircraft comprises a combined internal-combustion



engine and air-compressor a, having cylinders arranged at right-angles to one another as shown or otherwise, which delivers compressed air by way of reservoirs b, a pipe f, and a heater c of special construction to an engine g, which may be a turbine of the circular-flow type having repeated impact. The air-heater c, Fig. 3, consists of an asbestos-lined box traversed by the air tubes, which are heated by a regulable petrol or gas burner h having an electric igniter i. Air for combustion is supplied through a pipe j, the combustion products escaping through a pipe k.

TOOTHED GEARING.

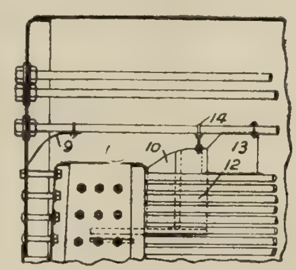
119,021.—D. BROWN & SONS and A. SYKES, Park Works, Lockwood, Huddersfield.—Oct. 4th, 1917.—In single or multiple helical gearing, the effects of transverse or torsional deflection are neutralised, and the pressures on the teeth are equalised, by forming wheels in three or more sections free to move axially on the shaft, and interconnecting the sections by mechanical devices comprising



levers mounted on the shaft. In the form shown, the wheel sections a, $a1$, $a2$, $a3$ are mounted slidably on keys c, and the sections are connected in pairs by pairs of two-armed levers n, mounted on studs m on each side of collars l fixed on the shaft. Each of the levers is pivoted to a short rod o fixed on one wheel-section and to a longer rod p passing through an opening in the first section and fixed on the next section.

STEAM-GENERATORS.

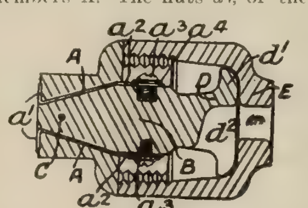
119,053.—PERFECTA BOILER CIRCULATOR LTD., P. C. AYRES, and H. W. E. JOSLING, 39, Victoria Street, Westminster.—June 22nd, 1917.—To promote the circulation in a marine boiler, a hood or curved deflecting plate 10 having depending side plates 12 is fitted in front of the combustion chamber across the full



width of the smoke-tubes, and a plate 13 is arranged to extend forwardly at an angle on one side of the hood so as to direct the circulation current across the boiler. A curved deflecting plate 9 extends from side to side of the boiler over the water space at the back of the combustion chamber. The deflecting plates are suspended from the boiler stays by hooked bolts 14. The plate 13 is secured at its upper edge to a bar attached to the stays.

ELECTRIC ADAPTERS.

119,119.—N. MCLEAN, 25, Grove Road, Harrogate, Yorkshire.—Oct. 17th, 1917.—In an adapter for connection to wall sockets, lamp sockets, etc., the bayonet pin and contact members are secured by moulding the insulating body of fibre or other suitable material with the pin and contact members in place in the mould. The contact members A and bayonet pin C are placed in a mould, the members A being held by screws, not shown, screwing into nuts $a4$ or into a tapped hole in the contact member. The body B of insulating material such as fibre is then moulded about the pin C and members A. The nuts $a4$, or the holes left by the

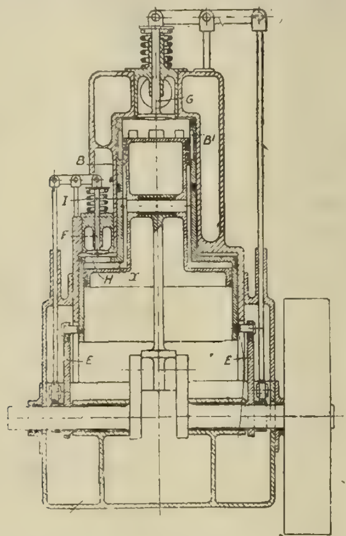


securing screws, serve for reception of terminal screws and washers $a3$ which are afterwards added. The members A are preferably of sheet metal bent to provide contact faces $a1$ cooperated with the plungers of the lamp socket, etc., and parts $a2$, preferably at right-angles to the parts $a1$, through which the screws $a3$ are passed. The body has an extension D with a

flange d1 and slot d2, strain being taken off the terminal screws by giving the leads one or two turns about the extension D behind the flange, and bringing them out centrally through the slot d2. The body B has screw-threads for reception of a cover E. Specification 112,240 is referred to.

INTERNAL-COMBUSTION ENGINES.

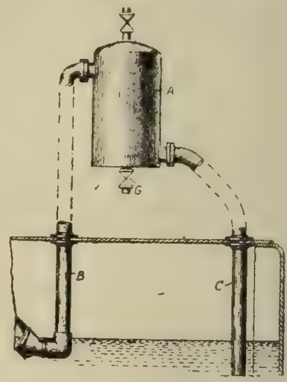
119,057.—C. G. BONEHILL, Woodroyd, Woodlands Road, Moseley, Birmingham.—Aug. 13th, 1917.—In an engine having a cylinder and piston of two diameters, a reciprocating sleeve valve B is



located between the piston and the cylinder, and charges compressed in the pump space x are transferred to the combustion space through passages in the piston which deliver into recesses or conduits in the sleeve valve. As shown, the sleeve valve is formed with an extension in which slides the annular pump piston. The valve is actuated by eccentrics E. An exhaust valve G is located in the head of the cylinder and an inlet valve F in the annular pump. Charges are drawn into the pump space below the annular portion of the sleeve valve through a port H, and during the admission period in the working cylinders they are transferred to the combustion space through a passage or passages I in the piston and a channel or channels B1 in the valve. According to the Provisional Specification, the sleeve valve may be dispensed with, the changes being transferred from the pump to the combustion chambers through passages in the piston and in the wall of the cylinder. The valve may be water-cooled and may be controlled by springs and by the pressure of the working fluid.

STEAM GENERATORS.

119,062.—S. J. WILFORD, 21, Terrace Road, South Hackney, London. Aug. 16th, 1917.—In apparatus for promoting the water circulation and consisting of a chamber A communicating with the boiler through pipes B, C of unequal lengths so that water



circulates through the chamber by syphonic action, the interior of the chamber is unobstructed by baffles, etc., and the pipes are so connected to the chamber that the water flows through it in a path that is everywhere descendent. Sludge is removed through a cock G. Specification 3593/09 is referred to.

INDEX TO ADVERTISERS.

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CONTENTS.

EDITORIAL.

FACTORS OF IGNORANCE.

IN any survey of industry, whether this is confined to one particular section or whether industry is considered entire, one of the most striking features is that ignorance bulks so largely in the sum total.

Lack of knowledge may be wilful; it is possible to sin against the light; may be unrealised, in spite of the quickened intellectual and technical atmosphere of the time; or may be unavoidable, since the sum total of realised knowledge pales into insignificance against the vast bulk of the unknown. If metaphysicians are right, all things, including truth, are relative, and as a consequence the absolute can never be won, only an approximation thereto.

Industry has, in the main, to deal with the evidence of things seen, not the substance of things hoped for. It is not concerned with the basic essentials of the constitution of matter, but with factors whose repetition is certain from proven and known essentials. Hence, industry only slowly absorbs the results of scientific discovery. To obtain manufacture on a large scale is always a problem of means, not of merit. To reduce to practice may take a dozen years spent without any return upon investment. The existing solution ot any material problem has in every case been wrought out with difficulty, patience, and mostly in the teeth of discouragement, and even in solved problems there are always insoluble factors and incommensurable quantities, the ignorance is usually greater than the knowledge.

The largest minds of which we have knowledge are usually those who most freely confess their ignorance. Seeing more deeply than most, they realise that the undiscovered territory is of vast extent. The small mind is vain of its attainments, the great intellect is willing to plead ignorance.

The assumption of knowledge without any sort of valid backing is a common modern obsession. To persuade others of omnipotence is not difficult if certain rules be observed. The claim is, however, sufficient to establish a contra *prima facie* case, for no man of real attainments has this attitude. To claim to be a specialist in any field is tantamount to a confession of ignorance in others. Indeed, most men are bound to sacrifice all-round competence to earn their living. This disposes of the opinions of the specialist in any field alien to his own; the greater his eminence in his own field the more certain that his opinion elsewhere is no better than that of any other man. It is a little curious how the newspaper press gives prominence to the general opinions of some expert in one particular direction. He would be the first to admit his ignorance in his own subject, but is all the more certain that his views elsewhere deserve more than ordinary attention.

Every man who trains for one profession warps his general intelligence to gain success, and the closer his application the more pronounced his specialisation; the greater the authority he becomes the more his general mentality must be warped.

Leonardo da Vinci, Shakespeare, Dante, Napoleon, and a few others are exceptions which prove the present contention, but save for the one mind in a century the rule applies.

We are ignorant in proportion to our knowledge whether it is inside or outside our particular activity. This applies generally to every technician,

engineer, doctor, lawyer or expert of any type. Probably there is more need than ever for the broadly-trained man whose outstanding feature is strong, unadulterated common sense, the lack of which has been a barrier to many estimable trained men when a post of great responsibility and large issues has to be filled. There is also a need for every expert to supplement the restricted viewpoint his activity affords by broad comprehension of the world of affairs around him.

Another matter is that intense training inhibits originality. This is so true that the tendency to crystallisation is most marked in the older professions, and the acceptance of new ideas is most stoutly resisted wherever practice has been settled any length of time.

There is always the tendency to "keep on keeping on" because of the momentum of the machine and disinclination to change inherent in almost every one. It is easier to follow than to break precedent, and whoever tries to do the latter always finds a dozen reasons for continuance to place against his own convictions.

The trouble in industry to-day is not to find qualified experts for particular fields so much as to secure a man broad enough in mentality to co-ordinate specialised effort, to bring unity of purpose out of sectionalised endeavour. Such a man must have a strong bias to resist the warpage of training, and must possess that most rare of qualities, constructive criticism.

Specific comprehension is no substitute for general intelligence, and the ignorance of the expert when he steps abroad is sometimes a matter for wonder and astonishment. It is perfectly obvious that no one mind can compass all modern knowledge; to attempt this would be a vain endeavour. There was a time when a single individual could carry all the knowledge of his era without undue or lifelong endeavour. There is, however, a marked tendency, even in abstruse subjects, after the initial period has passed to come within hailing distance or nodding acquaintance of ordinary intelligence. It is on this plane that broader understanding may be sought, and there is pressing need to simplify some of the experts' work for those located in allied fields.

WORKED EXAMPLES IN APPLIED MATHEMATICS.

By G. E. Gittins, B.Sc. (Lond.).

The following examples, taken mainly from past papers of London University, illustrate important principles, and it is hoped that the solutions may be helpful to young engineers reading the subject without the aid of a tutor. An elementary knowlege of the calculus on the part of the reader has been assumed.

Example 1.—The velocity of a particle in a straight line is given by the equation $v=k\sqrt{a^2-x^2}$, where k and a are constants and x is the distance of the particle from a fixed point in the line; prove that the motion is simple harmonic, and find the amplitude, and periodic time of the motion.

Solution.—Denoting distance by x and time by t, the general equation of simple harmonic motion may be written:

$$\frac{d^2x}{dt^2} = -\mu^2 x \text{ where } \mu \text{ is some constant.}$$

The solution of this equation (as may be easily verified by differentiating twice) is

$$x = A\cos\mu t + B\sin\mu t$$

where A and B are constants to be determined by given conditions. Also the periodic time of the motion is

$$T = \frac{2\pi}{\mu}.$$

These results are of great importance, and the student should be thoroughly familiar with them. Turning now to our example, we are given that

$$v = k\sqrt{a^2-x^2}$$

$$\text{Now } v = \frac{dx}{dt}, \text{ and } \frac{dv}{dt} = \frac{d^2x}{dt^2}.$$

$$\text{Also } \frac{dv}{dt} = k\cdot\frac{d}{dt}\sqrt{a^2-x^2} = \frac{-kx}{\sqrt{a^2-x^2}}\frac{dx}{dt}$$

$$= \frac{-kx}{\sqrt{a^2-x^2}}\cdot k\sqrt{a^2-x^2}$$

$$= -k^2x.$$

$$\text{Hence, since } \frac{dv}{dt} = \frac{d^2x}{dt^2}, \quad \therefore \frac{d^2x}{dt^2} = -k^2x.$$

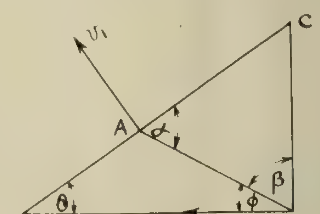
This result shows that the particle moves with simple harmonic motion. To find the amplitude, we remember that the velocity is zero at either of the extreme positions. Putting $v = o$, we get that

$$k\sqrt{a^2-x^2} = o \text{ or } x = \pm a$$

which gives the amplitude. The periodic time for a "to and fro" motion is

$$T = \frac{2\pi}{k}.$$

Example 2.—A rod OA is pivoted to a fixed point at O and is freely jointed at A to a second rod AB: the end B is constrained to move in a straight groove



Applied Mathematics.—Fig. 1.

passing through O. If the rod OA rotates about O with uniform angular velocity w, show that the velocity of B at any instant is OA $(\sin\theta + \cos\theta\tan\phi)\,w$ where θ and ϕ are the acute angles made by OB with OA and AB at the instant. Show also that if the rods are equal, the motion of B is simple harmonic.

Solution.—Let the positions of the rods at any instant be as shown in Fig. 1. We must first find the instantaneous centre of rotation of the rod AB. Since OA moves round O with uniform angular

velocity w, then the linear velocity v_1 of the point A is $w \times$ OA at right-angles to OA. Now, if C is the instantaneous centre of rotation of the rod AB, OA produced and BC drawn at right-angles to OB must meet in C. Let AB have instantaneous rotation w_1 round the centre C. Then we have that

$$\text{Velocity of A} = w_1 \times CA.$$

$$\text{Velocity of B} = w_1 \times CB.$$

$$\therefore \frac{\text{Velocity of B}}{\text{Velocity of A}} = \frac{w_1 \times CB}{w_1 \times CA} = \frac{CB}{CA}.$$

$$\text{But } \frac{CB}{CA} = \frac{\sin \alpha}{\sin \beta} = \frac{\sin(\theta + \phi)}{\cos \phi}$$

$$= \frac{\sin\theta\cos\phi + \cos\theta\sin\phi}{\cos\phi}$$

$$= \sin\theta + \cos\theta\tan\phi.$$

$$\therefore \text{Velocity of B} = \text{Velocity of A} \times (\sin\theta + \cos\theta\tan\phi).$$

$$\text{But velocity of A} = v_1 = w\,\text{OA},$$

$$\therefore \text{Velocity of B} = \text{OA}(\sin\theta + \cos\theta\tan\phi)\,w.$$

The latter part of the question requires us to show that the motion of B is simple harmonic, given that OA = AB. Denoting distance by x, and time by t, the general equation of simple harmonic motion is

$$\frac{d^2x}{dt^2} = -\mu^2 x.$$

Since in our particular case OA = AB, the point A bisects OC and OA = AB = AC.

Putting OA = r, we get at once that

$$x = OB = 2r\cos\theta,$$

$$\text{and } \frac{dx}{dt} = -2r\sin\theta\frac{d\theta}{dt}.$$

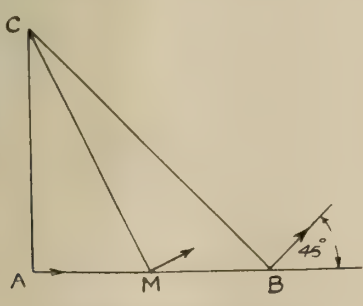
Bearing in mind that $w = \frac{d\theta}{dt}$ and differentiating again,

$$\frac{d^2x}{dt^2} = -2wr\cos\theta\frac{d\theta}{dt} = -2w^2r\cos\theta.$$

$$\text{But} \quad \cos\theta = \frac{x}{2r} \text{ and hence } \frac{d^2x}{dt^2} = -w^2x,$$

which shows that the point B has simple harmonic motion.

Example 3.—A straight rod AB, 4 ft. long, moves in a plane; the velocity of one end A is 20 ft. per second along AB; that of B is inclined 45 deg. to



Applied Mathematics.—Fig. 2.

AB. Find the velocity of B and that of the middle point of AB.

Solution.—In Fig. 2, let C be the instantaneous centre of motion of AB. Then since A moves along AB, CA is at right-angles to AB. Also since B moves at 45 deg., BC is at 45 deg. with AB. If w be instantaneous angular velocity round C, then

$$\text{velocity of A} = w \times AC$$

$$\text{and velocity of B} = w \times CB$$

$$\therefore \frac{\text{velocity of B}}{\text{velocity of A}} = \frac{BC}{AC} = \sqrt{2}$$

$$\text{and velocity of B} = \text{velocity of A} \times \sqrt{2}$$

$$= 20\sqrt{2} \text{ ft. per second.}$$

Again, velocity of middle point M is at right-angles to CM and $= w \times$ CM. But CM $= 2\sqrt{5}$.

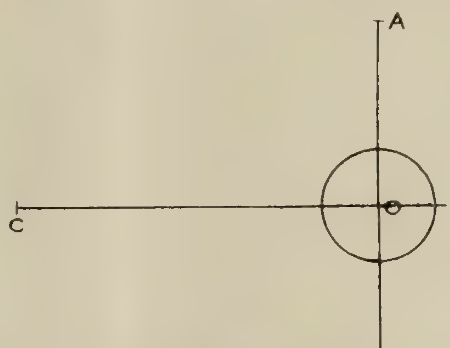
$$\therefore \text{Velocity of M} = \text{velocity of A} \times \frac{CM}{AC}$$

$$= 20 \times \frac{2\sqrt{5}}{4}$$

$$10\sqrt{5} \text{ ft. per second.}$$

Example 4.—The centre of a disc falls vertically with constant acceleration while the disc rotates in its own plane (which is vertical) with constant angular velocity. Find the locus in space of its instantaneous centre.

Solution.—In Fig. 3, let A be the initial position of the centre of the disc, and O the position when



Applied Mathematics.—Fig. 3.

the fall has lasted for t seconds. Then clearly AO $= \frac{1}{2}gt^2$ where "g" is the acceleration of the falling body. Also if C be the instantaneous centre then CO is at right-angles to OA. Again, the velocity of the centre of the disc when at O is gt, and hence

$$CO \times w = gt.$$

$$\therefore CO^2 = \frac{g^2t^2}{w^2} = \frac{2g}{w^2}.AO.$$

$$\text{since } AO = \tfrac{1}{2}gt^2.$$

Hence the locus of C in space is a parabola.

(To be continued.)

RAPID RECRYSTALLISATION ON NEWLY-FORMED NON-FERROUS METALS.

By D. Hanson, M.Sc.

(Concluded from page 156.)

70 : 30 Brass.

70 : 30 brass gave exactly similar results. The junction between coarse and fine crystals is shown in Fig. 3. The specimen was annealed for five minutes at 800 deg. Cen. The size of the coarse crystals which were developed is approximately the same as those produced in pure copper by similar treatment.

While it is realised that these results are in no way complete, and that considerable investigation is required before this remarkable phenomenon can properly be understood, yet it may be claimed that they have an important bearing on the recrystallisation of metals. In the case of a metal which has been uniformly strained, it is known that, in general, grain size produced by annealing is dependent on both the time and temperature of annealing. It would appear that the amount of previous strain has, in some cases, an even more profound effect. The extreme rapidity with which very coarse grains are produced under favourable conditions is most striking, while comparison between annealings which have been carried out on exactly similar specimens for widely differing periods of time indicate that, once the first rapid recrystallisation is effected, longer annealing at the same temperature has a relatively slow effect on the newly-formed grains. It would appear also that for every degree of deformation there is a critical temperature,

Rapid Recrystallisation.—Fig. 3.

or, perhaps, range of temperature, at which recrystallisation commences. Whether very prolonged annealing has the effect of appreciably widening this range remains to be tested.

The results described in this note suggest that the following law of annealing is probably applicable to all strained metals and solid solutions:

For every degree of deformation there is a critical recrystallisation temperature at which crystal growth is extremely rapid, and the size of the crystals produced by this rapid growth is the greater the smaller the amount of deformation preceding such annealing. The rate of increase in size of the newly-formed crystals with prolonged time and increased temperature of annealing is small compared with their rate of growth at the critical temperature.

Much further work is necessary before it can be said that this law is established. More especially is it necessary to study the first stages of this rapid growth, in order that the reasons which underlie it may be understood. The effect of allotropic transformations on this growth must also be studied. Coarsely crystalline iron is refined by heating through its Ac3 point, but, according to Chappell, not by passage through Ac2. Sherry, however, finds that refining is sometimes obtained at Ac2. Robin states that zinc and nickel both fail to become refined by passing through their critical points.

Alloys containing more than one constituent have not been examined. From analogy with steel it is expected that in these alloys coarse crystal growth will be limited by the presence of a second constituent. In any case, it is obvious that such recrystallisation can only occur in the continuous phase.

The effect of coarse crystallisation of this kind on the mechanical properties of materials also remains to be investigated. It is known that iron and very mild steels become weak, especially under impact and fatigue, as a result of this grain growth, and it is probable that a similar effect will be found in some alloys.

The author wishes to express his indebtedness to Sir Richard T. Glazebrook, C.B., F.R.S., Director of the National Physical Laboratory; and especially to Dr. W. Rosenhain, F.R.S., for his interest, advice, and encouragement during the course of this work.

(Concluded.)

GOVERNORS AND GOVERNING MECHANISM.

By A. Houlson.

(Continued from page 152.)

Reverting to the governor details, the principal stresses and bearing pressures are as follow:—Stress in eye-bolts screwed part $\frac{7}{8}$ in. Whitworth $= \frac{2490}{\cdot 422}$ $= 5,900$ lbs. per square inch.

Stress at section XY of governor weight $= \frac{987 \times 7\cdot125}{2\cdot95} = 2,380$ lbs. per square inch; 2.95 being the modulus in tension.

Bearing pressure on fulcrum pin F $1\frac{3}{8}$ in. diameter $= \frac{3477}{1\cdot375 \times 3\cdot125} = 808$ lbs. per square inch.

Bearing pressure on eccentric plate pin 1 in. diameter $= \frac{2490}{1 \times 3\cdot125} = 800$ lbs. per square inch.

Bearing pressure on eccentric sheave $= \frac{Q + R}{d\,w}$

where Q = inertia forces due to acceleration and retardation of valve gear $= .00034\ \mathrm{W}r\mathrm{N}^2\left(1 + \frac{r}{l}\right)$ lbs.

where: W = weight of valve, spindle and other reciprocating parts in lbs. In this case W must be multiplied by the ratio of rocking levers $= \frac{11\frac{9}{16}}{6\frac{5}{8}}$ or 1·74 to obtain the effective W at eccentric centre.

R = resistance to motion of valve due to friction of the rings in the liner bore, and the spindle in the stuffing box. The value of R can only be found by experiment, and in this case it amounted to 39 lbs. N = revolutions per minute; d = diameter of eccentric sheave in inches; w = width of eccentric sheave in inches; r = throw of eccentric in feet; l = length of eccentric rod in feet.

$$Q = \cdot 00034 \times 110 \times \cdot 0837 \times 40{,}000 \left(1 + \frac{\cdot 0837}{3 \cdot 375}\right)$$

$= 128.$

$R = 39 \times 1.74 = 68$; $d = 11\frac{3}{4}$ in.; $w = 1\frac{1}{4}$ in.

Hence bearing pressure on eccentric sheave

$$= \frac{128 + 68}{11\frac{3}{4} \times 1\frac{1}{4}} = 13.4 \text{ lbs. per square inch.}$$

The valve spindle diameter through the valve is calculated from the empirical formula: $.15 \times$ diameter of valve $+ \frac{1}{8}$ in. $= .7$, say $\frac{3}{4}$ in., and the diameter in the gland may be $\frac{7}{8}$ in.

For the larger valves the empirical constant gradually becomes less, for example, a 9 in. valve has a $1\frac{1}{8}$ in. spindle, the constant being .111. The valve guide may be made $1\frac{3}{4}$ in. diameter $\times 3\frac{1}{2}$ in. long.

The eccentric rod should be treated as a strut hinged at one end and fixed at the other. The mean diameter is $1\frac{1}{4}$ in. and the stress

$$= \frac{Q + R}{A}\left(1 + \frac{16\, l^2}{9 \times 30000 \times K^2}\right)$$

$$= \frac{196}{1 \cdot 227}\left(1 + \frac{16 \times 40 \cdot 5 \times 40 \cdot 5}{9 \times 30000 \times \cdot 0975}\right)$$

$= 318$ lbs. per square inch.

A = area of rod in square inches; l = length of rod in inches; K = radius of gyration.

The diameter of the two bolts in the eccentric sheave is such that their total area at bottom of thread is 10 per cent greater than the area of the eccentric rod at the smallest part. This works out to $\frac{7}{8}$ in. Whitworth.

The least thickness t of sheave (see Fig. 39) should be diameter of shaft $\div 3.75 = \frac{5 \cdot 5}{3 \cdot 75} = 1.46$, say $1\frac{1}{2}$ in.

The least strap thickness is found from the formula:—

$$\text{Thickness} = \text{Diameter eccentric bolts} \sqrt{\frac{\text{Constant}}{\text{width strap}}}$$

where the constant has the following values: 5 to 7 for cast iron; 2 to 2.75 for cast steel; and 3.5 to 4.5 for gun metal. This strap is of gun metal, therefore the thickness $= .875 \sqrt{\frac{3 \cdot 5}{1 \cdot 75}} = 1\frac{1}{4}$ in., say.

Table 9 enumerates the velocities of steam at various points in the cylinder passages and liner ports; based on the mean piston speed, reference to be made to Fig. 39.

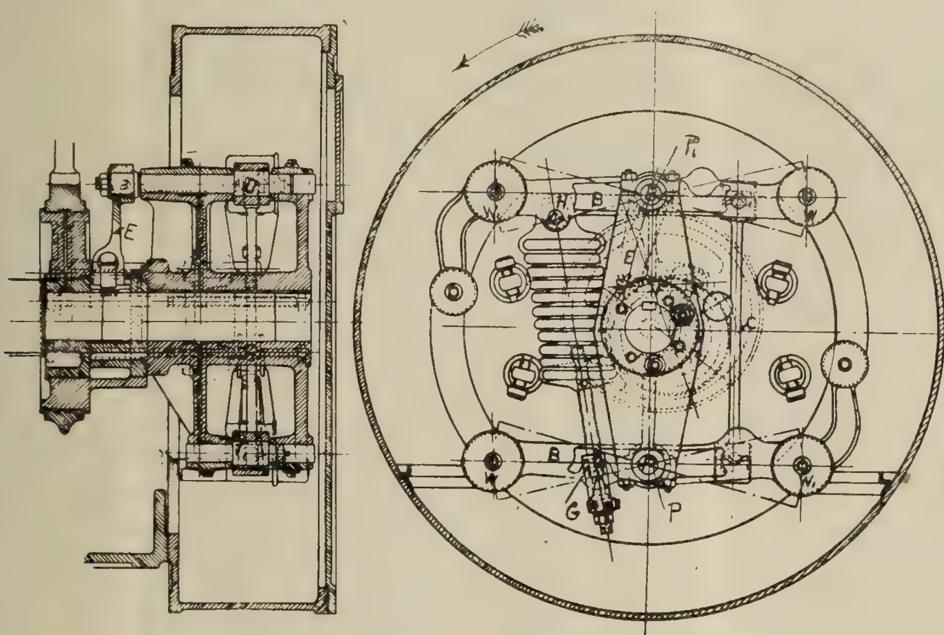


Fig. 42.—Governors.

Table 9.—Steam Velocities.

	Velocity ft. per sec.
Through steam passage G	42
Inlet slots R in valve liner	10
Past edge of valve at 60 per cent (latest) cut off	86
Past edge of valve at 30 per cent cut off	286
Past outer edge of valve liner at E	99
Past outer edge of valve liner at D	75
At narrowest part of cylinder port	64
Through full port S in liner	64
Through exhaust slots in liner	38
Through orifice H into receiver	48

When estimating the area at E, it must be remembered that the slot at E delivers one-quarter the

total quantity of steam required; therefore the velocity at E in feet per second =

$$\frac{\text{Area cylinder square inch} \times \text{Mean piston speed feet per minute.}}{4 \times \text{area E.M. square inch} \times 60.}$$

Piston Valve Governors.

Fig. 42 shows a rather more complicated form of piston valve governor, in which the force of inertia is utilised in addition to the centrifugal force.

The governor consists of a plate carrying two

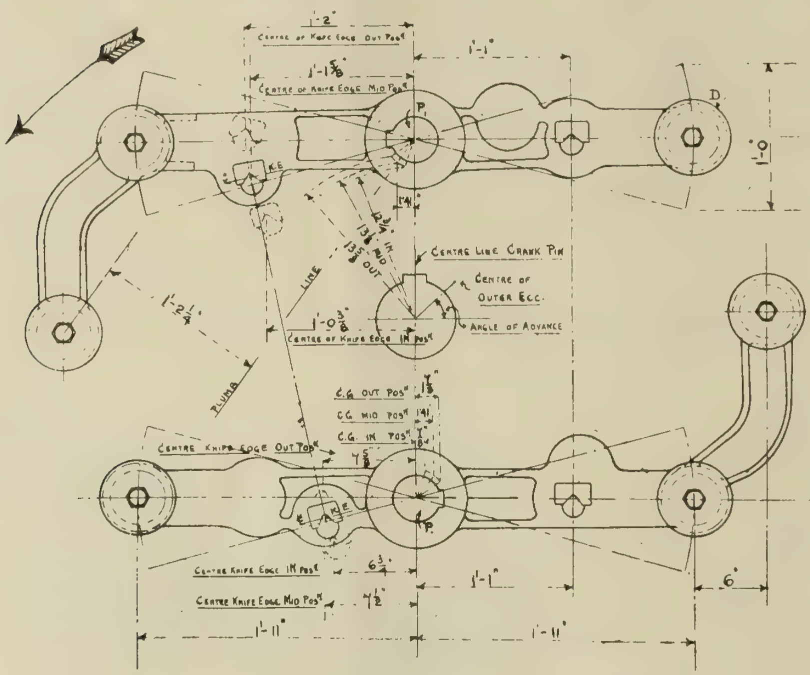


FIG. 43.

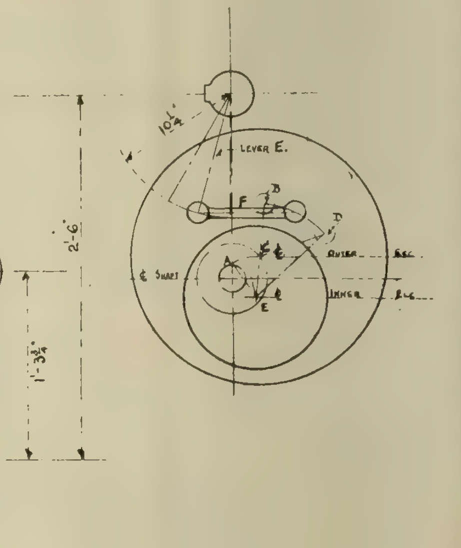


FIG. 44.

GOVERNORS.

inertia bars pivoted at points P and P_1. The plate is a forcing fit on the shaft to which it is keyed. The bars are coupled by the link C, and so oscillate through equal angles. Owing to the left-hand half of the top bar being heavier than the right-hand half, and *vice versa* for the lower bar, the centre of gravity of each bar is in the position as shown in Fig. 43. The governor spring is not attached at points equidistant from the pivots P, P_1, because it would have no controlling effect on the governor.

Referring to Fig. 42, the point of the spring attachment G in the bottom lever is nearer the pivot P than the point H in the top lever is to the pivot P_1;

By similar reasoning the velocity at D in feet per second =

$$\frac{3}{8} \times \frac{\text{Area cylinder square inch} \times \text{Mean piston speed feet per minute.}}{\text{Area D.M. square inch} \times 60.}$$

Table 10 gives a list of piston valves for various sizes of cylinders both high and low pressure.

TABLE 10

High Pressure.		Low Pressure.	
Diameter Cylinder.	Diameter Valve.	Diameter Cylinder.	Diameter Valve.
7	$3\frac{1}{2}$	11	$4\frac{1}{2}$
8	$3\frac{3}{4}$	16	$5\frac{3}{4}$
16	$8\frac{1}{2}$	26	11
23	$11\frac{1}{2}$	36	15
25	16	42	19

The centre line of the valve should be below the centre line of the cylinder, as in Fig. 39, to ensure good drainage, and steam should be admitted to the inside edges of the valve as shown in the Fig., the packing will then be relieved of high pressure.

A small valve with a long travel is preferable for two reasons; the lap is greater, and the circumference is less, both tending to reduce leakage, which is so detrimental to satisfactory governing.

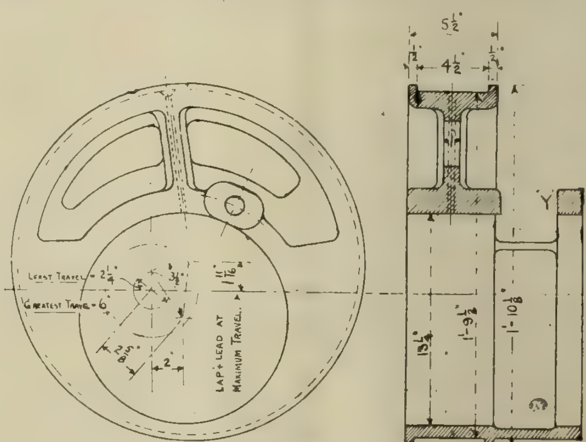


FIG. 45.—GOVERNORS.

consequently, the point H has to move through a greater distance than the point G when the governor opens, and so the spring is extended. This controls the centrifugal force of the bars.

The governing of the engine is accomplished by varying the position of the eccentric centre relatively to the centre of the crank-shaft, and thus varying the travel of the piston valve.

On the crank-shaft is placed an inner eccentric Fig. 46, bolted to the governor plate, thus rotating with it. The outer eccentric Fig. 45 is bored out to, and rotates on, this inner eccentric.

When the inertia bars move outwards the lever E, see Fig. 44, pulls the link F and so rotates the outer eccentric on the inner one. Consequently, the centre of the outer eccentric will move on an arc of a circle struck from the centre of the inner eccentric.

The travel of the piston valve is equal to twice

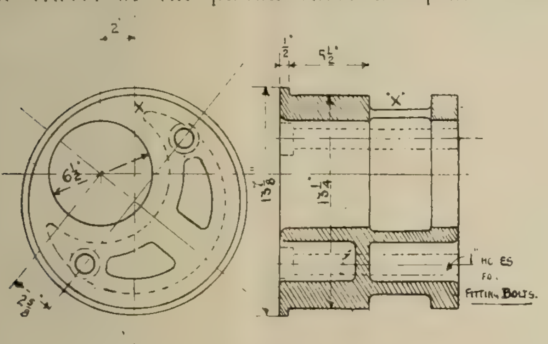


Fig. 46.—Governors.

the distance from the centre of the crank-shaft to the centre of the outer eccentric.

There are several advantages in this arrangement. It is convenient to reduce the lead to zero at the outer position of the governor, *i.e.*, at the point of minimum valve travel, so that we may have a reduced port opening at light loads. Also, this design enables the lead to increase gradually and smoothly until it reaches a maximum at the largest travel. Again, it will be noticed that the inner eccentric takes all the thrust of the valve gear so that the friction has very little disturbing effect on the governor. Should the change in load take place suddenly, the inertia of the bars helps the centrifugal force to make a swift change in the position of the eccentric. For instance, if the engine suddenly accelerated its speed the inertia bars would lag behind, and in so doing help the centrifugal force.

(*To be continued.*)

CENTRIFUGAL PUMPS FOR DEALING WITH LIQUIDS CONTAINING SOLID, FIBROUS, AND EROSIVE MATTERS.*

By the Hon. Richard Clere Parsons, M.A., M.Inst.C.E.

When in sewage-disposal works pumping is required, it is the practice to remove all suspended solid matters in the sewage by screens or by collecting in sumps. It is obvious that a pump which will pass all these solid matters would avoid the capital cost of screens, dredgers and the labour involved, and would further lend itself to the pumping of sewage from flat districts, for which work it is usual to employ the hydraulic method or a pneumatic device such as the Shone and similar systems of pumping.

The Stereophagus Pump.

The author has designed and constructed a pump which satisfactorily fulfils these requirements, and to this the name of "Stereophagus" has been given. This pump is fully described in *Engineering*, vol. xcii. (1912), page 444; it will, therefore, suffice to say here that it contains a conical impeller provided with a number of spiral blades which work against a slanting straight blade, giving a cutting action similar to that of an ordinary lawn-mower. This pump is provided with a suction orifice in which the necessary area is given by a narrow slit varying in width and length with the size of the pump. This slit causes no hindrance to the entry of fibrous and other matters, but prevents long sticks or pieces of wood of large size from choking the pipes leading to the pump.

In districts drained with the help of these pumps, on what might be called the Stereophagus system, the advantage shown over either the hydraulic or pneumatic systems is the substitution of pumping mains at atmospheric pressure and of large size with a gravitational flow, for smaller cast-iron pumping-mains with flow under pressure, and the consequent reduction effected in the loss by friction.

When these pumps are used they are generally driven by electric motors, which are stopped and started by means of floats; and in order to secure the highest possible efficiency of the system, the variation in the level of the sewage in the well is made as small as possible. With the Stereophagus pump this variation can be made much less than in either the hydraulic or pneumatic system, and a considerable saving in the power of the machine required is thus effected.

With low-pressure pumping-mains it becomes necessary to pump the sewage at comparatively frequent intervals, as the amount of fall available in each section of the pumping-main is limited; but although the pumping is more frequent, the absence of friction has the effect of making the total head against which the pumps have to work considerably less, and there is thus a marked saving in the power employed.

It may naturally be said that pumping-mains in which the flow is by gravitation might be made use of in the hydraulic or pneumatic systems, but it is found impracticable with either of these classes of machinery to pump the same sewage several times over, as the consequent accumulation of sewage in the larger stations would necessitate the use of large and very costly hydraulic pumps or pneumatic ejectors.

On the other hand, centrifugal pumps involving only a comparatively small capital expenditure are capable of dealing with large quantities of sewage with low lifts, and under these circumstances its efficiency is considerably higher than that of either of the other two types of pumping machinery.

* Abstract of a paper read at the ordinary meeting of the Institution of Civil Engineers, on Tuesday, the 28th January, 1919.

A comparison is made between a district actually drained by the hydraulic system and carefully worked out schemes for the drainage of the same district by the pneumatic system and by the Stereophagus system, and the great advantage of the latter both in capital cost and working expenses is demonstrated by detailed tables.

Drainage of the City of Recife (Pernambuco).

A description is also given of the drainage of the City of Recife (Pernambuco), Brazil, in which the Stereophagus system has been adopted by the engineer, Dr. F. S. Rodiques de Brito, who, as the result of 2½ years' experience, finds that Stereophagus pumps have worked more satisfactorily than the ordinary centrifugal pumps installed in some districts of the city, and that they obviate the cleansing of the wells, which is necessary with ordinary centrifugal pumps.

Plans have also been prepared for the drainage of Petrograd by the Stereophagus system.

Details of a test of the Stereophagus pump are given in which one of these pumps was set to pump the sewage of the City of Leeds for a period of 30 days, and it was found that during the test no obstruction of the pump occurred, although much solid matter passed through it, including road grit. It was observed, however, at the conclusion of the test, that a just perceptible wear had occurred between the edges of the impeller blades and the casing. The impeller was therefore slightly advanced, and the efficiency was completely restored.

Tests were then made with the same Stereophagus pump for raising sewage sludge from the precipitation pits, and the results showed that it was well suited for performing this operation.

Up to the present time about 250 Stereophagus pumps have been constructed and are in use for services similar to that described above, for which they have given every satisfaction.

Although the Stereophagus pump has been so successful in dealing with liquids containing fibrous and solid matters, it appeared to be possible to construct another type of pump which would be more suitable for dealing with liquids of a corrosive nature or containing erosive matter.

The result has been the designing of the Flexala pump, which, as its name implies, has flexible vanes. This pump is of the ordinary single-inlet centrifugal type. The impeller consists of a cast-iron centre, the boss of which screws on to the spindle of the pump: in one with this boss is a flat-circular plate, on to the surface of which is vulcanised a layer of pliant rubber, and out of it spring the curved rubber blades of the impeller. This impeller is in close proximity to the centre face of the cover of the pump, and in this face spiral grooves are placed in the direction of the track of the water passing through the impeller. This face may also be coated with rubber, and in cases where the erosive action is very marked, or where the liquid is of a very corrosive nature, the whole of the internal surface is lined with rubber.

In both the Stereophagus and Flexala pumps the impeller is provided with the usual balancing vanes at the back, but in addition to these an automatic balance is obtained by the admission of a small quantity of air into the pump when in operation, which causes the centrifugal action of the vanes at the back of the impeller to equal that of the vanes at the front, through which the head of the pump may vary.

A large number of Flexala pumps have been constructed, and have yielded satisfactory results.

SAFETY FIRST.

As indicated by the formation of the British Industrial "Safety First" Association, under the Presidency of Lord Leverhulme, and the most eminent auspices in the worlds of labour and capital, nothing which ensures the worker against accidents (and, concurrently, the master against loss) will be omitted any longer from the nation's programme. In instance, take the case of heavy machinery, and, indeed, of all machinery subject to vibration. The tendency of the nuts in ordinary use to slack back or be shaken off has always been a fruitful source of accidents, and the problem of eliminating such accidents by the production of a nut which would defy all vibration was for a long time considered insoluble. Engineers would declare that it could not be done. So it happens that industry has been taxing itself each year in enormous costs for loss and damage and inefficiency.

But the problem has yielded to perseverance, as almost every problem yields in the long run, and master and man can now find protection equally. The man is protected against peril to life and limb; the master against loss of time and loss of efficiency. For during the somewhat shrouded years of war, while D.O.R.A. has been throwing her cloak of secrecy over many startling phases of applied science, substantial interest and lively enthusiasm has been kindled among engineers and Government departments by the automatic lock-nut called Vislok, which is known to provide an absolute and permanent lock despite continuous and intensified vibration. We have recently come across the booklet which Vislok Ltd. publish from 3, St. Bride's House, Salisbury Square, London, E.C. 4, and in which they record some of Vislok's achievements and the really remarkable area over which it has vindicated its claims. To-day, it appears, all the up-to-date firms use Vislok, and we strongly advise any outside the informed circle to apply for a copy of the booklet.

THE INSTALLATION AND OPERATION OF STATIC TRANSFORMERS.

By F. Ashton.

(Continued from page 110.)

Auto-Transformers.

An auto-transformer differs from an ordinary transformer in that it has only one winding. Current at a pressure lower than the supply pressure is obtained by providing the winding with a tapping at some intermediate point, as shown, for instance, in Fig. 23, where the auto-transformer is supposed to be used for starting a motor at reduced pressure. By connecting the motor between one end of the

winding and the tapping, the machine will obviously receive a lower pressure than that across the mains, and the initial rush of current will consequently be reduced. But when the motor has gained speed the full line pressure can be brought into action by cutting out the auto-transformer with the aid of a throw-over switch. In the case of a three-phase motor there is usually an auto-transformer winding in each of the three line wires, and these windings are connected star-fashion, the throw-over switch being provided with a fourth blade, so that when the switch is transferred to the full-pressure contacts, the fourth blade breaks the three neutral connections with the result that the auto-transformer windings are only energised during the starting period. The voltage that is drawn from the low-pressure wires of an auto-transformer obviously depends upon the position of the intermediate tapping. If the tapping is exactly in the centre of the winding, then

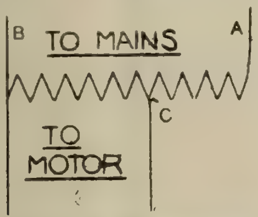


Fig. 23.—Auto-transformer.

the pressure between the low-pressure wires will be half that across the mains. If, on the other hand, the complete coil contains, say, 120 turns, and the number of turns between the low-pressure wires (that is, between one end of the coil and the tapping) is 40, then clearly the ratio of transformation will be three to one. Hence, if the supply pressure be 300 volts, the reduced pressure will be 100 volts. Conversely, current at the latter pressure might be fed into the low-pressure wires, whilst current at 300 volts might be drawn from the ends of the coil. In other words, auto-transformers can be used for raising or lowering voltages in the same way as ordinary transformers having primary and secondary windings. For practical purposes it will be convenient to neglect losses.

Current Distribution in an Auto-Transformer.

In an auto-transformer there are three currents to be considered: I_1, the line current which circulates between A and C; I_2, the current between B and C; and the load current $(I_1 + I_2)$. If N_1 and N_2 represent the number of turns between AC and CB respectively, then $N_1 I_1 = N_2 I_2$. If E_1 and E_2 are the line and load voltages respectively, then in an auto-transformer the four following conditions must be fulfilled:—

$$N_1 I_1 = N_2 I_2.$$
$$E_1 \div E_2 = (N_1 + N_2) \div N_2.$$
$$\text{Load current} = I_1 + I_2.$$
$$E_1 I_2 = E_2 (I_1 + I_2).$$

Assuming that between A and C (Fig. 23) there are 80 turns, and between C and B 40 turns, then clearly the current I_1 need only be half of the current of I_2 in order to produce the same magnetising effect upon the iron core. With a total load current of, say, 60 amperes, two-thirds of this current, or 40 amperes, will be the current I_2, and one-third, or 20 amperes, the current I_1. With the supply voltage mentioned, viz., 300 volts, the input and output will be 20×300 and 60×100 watts respectively. In passing back to the point B, the load current is divided into its components I_1 and I_2, the former returning to the line and the latter circulating between the winding BC and the load. The number of turns in the coil of an auto-transformer is the same as would be necessary if it were used exclusively for the high-tension winding of an ordinary transformer with a separate low-tension winding. Furthermore, when the transformation ratio is two to one or one to two, the amount of copper in the coil is exactly the same as that of a high-tension winding of an ordinary transformer of corresponding output. Hence, it will be seen that owing to the absence of an independent low-tension winding in an auto-transformer there is a saving in copper. Less iron is also needed, and the efficiency is higher. But it is to be noted that it is only in the case of a two to one or a one to two transformation ratio that the cross-sectional area of the winding should be uniform throughout. The saving in constructional cost increases regularly as a one to one ratio is approached, and decreases to nearly zero for an extremely large ratio. In constructing an auto-transformer the two portions of the copper windings should be designed for the respective currents they have to carry. In one portion the current will be the high-tension current, whilst in the other portion the current will be equal to the difference between the low-tension current and the high-tension current. The magneto-motive force of the current in one portion of the coil is directly opposed to that of the current in the other portion.

The Use of Auto-Transformers.

The disadvantage of an auto-transformer is obviously that the high and low-tension circuits are not insulated from one another, and for this reason auto-transformers are seldom used on ordinary high-tension circuits. They are, however, largely employed for other purposes, such as for the starting of squirrel-cage induction motors, and for the balancing of three-wire direct-current systems. When metallic filaments were first introduced a considerable number of these transformers were installed on consumers' premises with a view to reducing the pressure to a value which would permit the use of lamps of normal candle powers, but later developments in connection with these lamps rendered the use of auto-transformers unnecessary. When auto-transformers are used for starting motors, it is fairly common practice to provide more than one tapping, so that the voltage applied to the motor can be increased in steps. For starting three-phase motors two "V"-connected auto-transformers may be used instead of three star-connected transformers, as described at the beginning. Auto-transformers are also used on certain single-phase locomotives to reduce the pressure to a value suitable for the motors. The employment of auto-transformers for this purpose is dictated by convenience rather than economy; but, at the same time, experience gained on American single-phase lines has shown that an auto-transformer with a ratio of 22 to 1, and with a line pressure of 11,000 volts, is less expensive and more efficient than a two-winding transformer of corresponding output. Auto-trans-

formers have occasionally been used to ensure the proper division of load between other transformers working in parallel. It is well-known that when the percentage impedances of two transformers have been made equal they will divide the load between them, provided, of course, that the transformation ratios are equal. But if there is a difference in the transformation ratios, the secondary voltages will be unequal at all loads. If then two such transformers are connected in parallel, local currents will be set up in the windings, irrespective of the load, and when the transformers are loaded this local current will be superposed upon the load current. The greater the difference between the transformer voltages, the greater is the local current. Clearly this local current gives rise to a continual loss all the time the transformers are connected in parallel, and it is desirable that the local current should be eliminated. This may be done with the aid of an auto-transformer, inserted between either the primary or secondary windings, having different voltage ratios. The auto-transformer should be wound for the maximum difference in voltage between the two transformers and for the maximum current the transformers have to deal with. If this auto-transformer be connected, say, between two of the secondary ends that are normally joined together to form one of the parallel connections, a tapping in the centre of the auto-transformer will give equal division of load, connected between this tapping and the two opposite ends of the main transformer windings that are joined together. The current in one side of the auto-transformer will bear to that in the other side the inverse ratio of the number of turns in the two sides, and the division of load between the two ordinary transformers will be fixed by the position of the intermediate tapping. The local circulating current will be limited to the value necessary for magnetising the auto-transformer core.

(To be continued.)

DYNAMIC BRAKES.

By D. Riley.

Dynamic brakes, or more commonly called centrifugal brakes, are frequently used in connection with hoisting gears, but some misapprehension is prevalent as to the functions of this type of brake. The fact is that it is not a brake in the ordinary sense, that it is capable of arresting and holding the load, but is simply a governor which controls the speed of lowering, and prevents acceleration beyond a prearranged limit. It is not always necessary therefore to fit this type of brake, because in many cases there already exists a controlling influence in other parts of the machinery, generally in the main load brake.

If the gear is driven by a direct-current motor, fitted with a solenoid brake in series, a dynamic brake is not necessary, because, as the speed of lowering increases, the armature current decreases, and when this is reduced below the amount at which the solenoid pulls off, the latter will release and the solenoid brake will take charge of the load. If, however, a shunt coil is used, the current through the coil is not reduced, and the solenoid will continue to hold the brake off, so that the load may race; here a dynamic brake is very desirable.

When driving by induction motors, the dynamic brake is not necessary, as these motors are not subject to racing, but, in any case, whether D.C. or A.C. motors are used, and a hand release is fitted to the solenoid brake, which has become almost

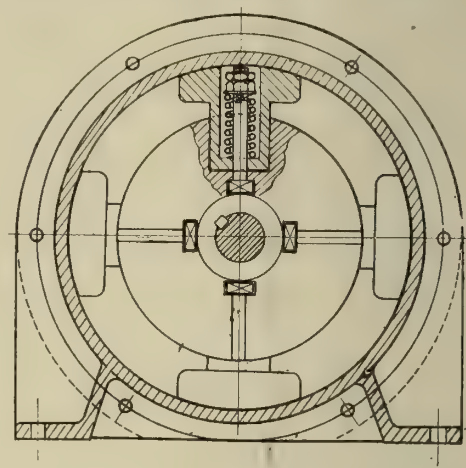


Fig. 1.

universal practice with crane makers, a dynamic brake is again desirable if the gear is to be independent of the driver.

Fig. 1 shows a type of dynamic brake. The hub is mounted on the motor spindle extension shaft, or the second motion shaft, and is usually cast in good grey iron, machined all over and perfectly balanced. The weights should also be machined all over, and care taken that they are all equal. The outer casing is cast in one solid ring and fitted with two flanges carrying the bearings. The flanges are spigoted in the casing and the joint made oil-tight, as it is advantageous to run this type of brake in oil. The braking surfaces should be large to radiate the heat generated.

In Fig. 2, the load W drives the machine in the reverse direction when lowering, and, with all brakes cut out, is free to accelerate, at some rate less than 32 ft. per second per second, dependent on the

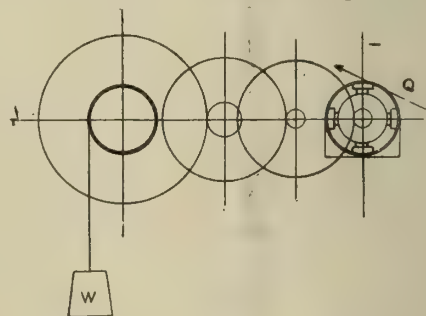


Fig. 2.

friction in the machine and the inertia in the moving parts. Now let us assume that the lowering speed must be limited to V ft. per second by means of a dynamic brake. Then according to Newton's laws of motion, a body moving at V ft. per second will continue to move at that speed unless acted upon by some external force. The external forces acting

Weights of Lengths of Rolled Steel Sections.

Beam 12 in. × 12 in. × 80 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	7 0 16	0 14 1 4	1 1 1 20	1 8 2 8	1 15 2 24	2 2 3 12	2 10 0 16	2 17 0 16	3 4 1 4	0
1	0 2 24	7 3 12	0 15 0 0	1 2 0 16	1 9 1 4	1 16 1 20	2 3 2 8	2 10 2 24	2 17 3 12	3 5 0 0	1
2	1 1 20	8 2 8	0 15 2 24	1 2 3 12	1 10 0 0	1 17 0 16	2 4 1 4	2 11 1 20	2 18 2 8	3 5 2 24	2
3	2 0 16	9 1 4	0 16 1 20	1 3 2 8	1 10 2 24	1 17 3 12	2 5 0 0	2 12 0 16	2 19 1 4	3 6 1 20	3
4	2 3 12	10 0 0	0 17 0 16	1 4 1 4	1 11 1 20	1 18 2 8	2 5 2 24	2 12 3 12	3 0 0 0	3 7 0 16	4
5	3 2 8	10 2 24	0 17 3 12	1 5 0 0	1 12 0 16	1 19 1 4	2 6 1 20	2 13 2 8	3 0 2 24	3 7 2 12	5
6	4 1 4	11 1 20	0 18 2 8	1 5 2 24	1 12 3 12	2 0 0 0	2 7 0 16	2 14 1 4	3 1 1 20	3 8 2 8	6
7	5 0 0	12 0 16	0 19 1 4	1 6 1 20	1 13 2 8	2 0 2 24	2 7 3 12	2 15 0 0	3 2 0 16	3 9 1 4	7
8	5 2 24	12 3 12	1 0 0 0	1 7 0 16	1 14 1 4	2 1 1 20	2 8 2 8	2 15 2 24	3 2 3 12	3 10 0 0	8
9	6 1 20	13 2 8	1 0 2 24	1 7 3 12	1 15 0 0	2 2 0 16	2 9 1 4	2 16 1 20	3 3 2 8	3 10 2 24	9

Weight of Beam, advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q lbs.	q. lbs.	Weight.
	6·7	13·4	20·1	26·8	1 5·5	1 12·2	1 18·9	1 25·6	2 4·3	2 11	2 17·7	2 24·4	

Weights of Lengths of Rolled Steel Sections.

Beam 12 in. × 12 in. × 80 lbs. per foot.

[ALL RIGHTS RESERVED.]

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 11 1 20	7 2 3 12	10 14 1 4	14 5 2 24	17 17 0 16	21 8 2 8	25 0 0 0	28 11 1 20	32 2 3 12	0
10	0 7 0 16	3 18 2 8	7 10 0 0	11 1 1 20	14 12 3 12	18 4 1 4	21 15 2 24	25 7 0 16	28 18 2 8	32 10 0 0	10
20	0 14 1 4	4 5 2 24	7 17 0 16	11 8 2 8	15 0 0 0	18 11 1 20	22 2 3 12	25 14 1 4	29 5 2 24	32 17 0 16	20
30	1 1 1 20	4 12 3 12	8 4 1 4	11 15 2 24	15 7 0 16	18 18 2 8	22 10 0 0	26 1 1 20	29 12 3 12	33 4 1 4	30
40	1 8 2 8	5 0 0 0	8 11 1 20	12 2 3 12	15 14 1 4	19 5 2 24	22 17 0 16	26 8 2 8	30 0 0 0	33 11 1 20	40
50	1 15 2 24	5 7 0 16	8 18 2 8	12 10 0 0	16 1 1 20	19 12 3 12	23 4 1 4	26 15 2 24	30 7 0 16	33 18 2 8	50
60	2 2 3 12	5 14 1 4	9 5 2 24	12 17 0 16	16 8 2 8	20 0 0 0	23 11 1 20	27 2 3 12	30 14 1 4	34 5 2 24	60
70	2 10 0 0	6 1 1 20	9 12 3 12	13 4 1 4	16 15 2 24	20 7 0 16	23 18 2 8	27 10 0 0	31 1 1 20	34 12 3 12	70
80	2 17 0 16	6 8 2 8	10 0 0 0	13 11 1 20	17 2 3 12	20 14 1 4	24 5 2 24	27 17 0 16	31 8 2 8	35 0 0 0	80
90	3 4 1 4	6 15 2 24	10 7 0 16	13 18 2 8	17 10 0 0	21 1 1 20	24 12 3 12	28 4 1 4	31 15 2 24	35 7 0 16	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight
	35 14 1 4	71 8 2 8	107 2 3 12	142 17 0 16	178 11 1 20	214 5 2 24	250 0 0 0	285 14 1 4	321 8 2 8	357 2 3 12	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 14 in. × 12 in. × 96 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	8 2 8	0 17 0 16	1 5 2 24	1 14 1 4	2 2 3 12	2 11 1 20	3 0 0 0	3 8 2 8	3 17 0 16	0
1	0 3 12	9 1 20	0 18 0 0	1 6 2 8	1 15 0 16	2 3 2 24	2 12 1 4	3 0 3 12	3 9 1 20	3 18 0 0	1
2	1 2 24	10 1 4	0 18 3 12	1 7 1 20	1 16 0 0	2 4 2 8	2 13 0 16	3 1 2 24	3 10 1 4	3 18 3 12	2
3	2 2 8	11 0 16	0 19 2 24	1 8 1 4	1 16 3 12	2 5 1 20	2 14 0 0	3 2 2 8	3 11 0 16	3 19 2 24	3
4	3 1 20	12 0 0	1 0 2 8	1 9 0 16	1 17 2 24	2 6 1 4	2 14 3 12	3 3 1 20	3 12 0 0	4 0 2 8	4
5	4 1 4	12 3 12	1 1 1 20	1 10 0 0	1 18 2 8	2 7 0 16	2 15 2 20	3 4 1 4	3 12 3 12	4 1 1 20	5
6	5 0 16	13 2 20	1 2 1 4	1 10 3 12	1 19 1 20	2 8 0 0	2 16 2 8	3 5 0 16	3 13 2 24	4 2 1 4	6
7	6 0 0	14 2 8	1 3 0 16	1 11 2 24	2 0 1 4	2 8 3 12	2 17 1 20	3 6 0 0	3 14 2 8	4 3 0 16	7
8	6 3 12	15 1 20	1 4 0 0	1 12 2 8	2 1 0 16	2 9 2 24	2 18 1 4	3 6 3 12	3 15 1 20	4 4 0 0	8
9	7 2 24	16 1 4	1 4 3 12	1 13 1 20	2 2 0 0	2 10 2 8	2 19 0 16	3 7 2 24	3 16 1 4	4 4 3 12	9

Weight of Beam, advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight
	8	16	24	1 4	1 12	1 20	2 0	2 8	2 16	2 24	3 4	3 12	

Weights of Lengths of Rolled Steel Sections.

Beam 14 in. × 12 in. × 96 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 5 2 24	8 11 1 20	12 17 0 16	17 2 3 12	21 8 2 8	25 14 1 4	30 0 0 0	34 5 2 24	38 11 1 20	0
10	0 8 2 8	4 14 1 4	9 0 0 0	13 15 2 24	17 11 1 20	21 17 0 16	26 2 3 12	30 8 2 8	34 14 2 4	39 0 0 0	10
20	0 17 0 16	5 2 3 12	9 8 2 8	13 14 1 4	18 0 0 0	22 5 2 24	26 11 1 20	30 17 0 16	35 3 0 12	39 8 2 8	20
30	1 5 2 24	5 11 1 20	9 17 0 16	14 2 3 12	18 8 2 8	22 14 1 4	27 0 0 0	31 5 2 20	35 11 2 20	39 17 0 16	30
40	1 14 1 4	6 0 0 0	10 5 2 20	14 11 1 20	18 17 0 16	23 2 3 12	27 8 2 8	31 14 1 4	36 0 0 0	40 5 2 24	40
50	2 2 3 12	6 8 2 8	10 14 1 4	15 0 0 0	19 5 2 24	23 11 1 20	27 17 0 16	32 2 3 12	36 8 2 8	40 14 1 4	50
60	2 11 1 20	6 17 0 16	11 2 3 12	15 8 2 8	19 14 1 4	24 0 0 0	28 5 2 24	32 11 1 20	36 17 0 16	41 2 3 12	60
70	3 0 0 0	7 5 2 24	11 11 1 20	15 17 0 16	20 2 3 12	24 8 2 8	28 14 1 4	33 0 0 0	37 5 2 24	41 11 1 20	70
80	3 8 2 8	7 14 1 4	12 0 0 0	16 5 2 24	20 11 1 20	24 17 0 16	29 2 3 12	33 8 2 8	37 14 1 4	42 0 0 0	80
90	3 17 0 16	8 2 3 12	12 8 2 8	16 14 1 4	21 0 0 0	25 5 2 24	29 11 1 20	33 17 0 16	38 2 3 12	42 8 2 8	90
Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight
	42 17 0 16	85 14 1 4	128 11 1 20	171 8 2 8	214 5 2 24	257 2 3 12	300 0 0 0	342 17 0 16	385 14 1 4	28 11 1 20	

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

ENGINEERING APPOINTMENTS OPEN.

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FOREMAN OF MACHINE SHOP REQUIRED for Controlled Works in S. London. Applicant must have held similar position previously, and by his personality and experience in the control of men, and the latest methods in production, be capable of securing the best output on all classes of Modern Machine Tools. The position is of a permanent character to suitable man. No one already engaged on Government work or living more than 10 miles distant need apply.—Address, F.M.S., c/o Dixon's, 195, Oxford Street, W.1.

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DRAUGHTSMAN, with good, all-round mechanical knowledge, Wanted by Engineering Works in North London. Preferably one conversant with locomotive and carriage design. Permanent situation to suitable man. Replies, giving full particulars, to Chief Draughtsman, Box No. 13, "Industrial Engineer."

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ENGINEERS, DRAUGHTSMEN, AND MECHANICS.

WANTED, Sheerness District, good Civil Engineering DRAUGHTSMAN, experienced in Surveying and general Building Construction. Ineligible for military service.—Apply, by letter, stating age, salary required, full particulars of experience and enclosing copy of recent testimonials, to Box 548, Willings, 125, Strand, London, W.C.2.

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PERSONAL NOTES.

The death occurred, on January 28th, of **Mr. William Cordrey,** a governing director of Messrs. W. H. Willcox and Co. Ltd., 38, Southwark Street, London, S.E.1, and a partner of Mr. W. H. Willcox in the original business.

We deeply regret to announce that **Mr. H. Doo,** Assistant Secretary of the Anglo-Mexican Petroleum Co. Ltd., died of influenza on the 12th inst., after a brief illness. His death is a great loss to the company, with whom he has been associated for several years, and is a matter of genuine sorrow to his colleagues, by whom he was universally esteemed.

Mr. L. J. Kettle, deputy electrical engineer, has been appointed chief engineer by the Dublin Electricity Committee for six months, *vice* Mr. M. Ruddle, resigned. His salary will be £750 a year and war bonuses, which will bring it up to about £1,000 a year.

Mr. T. Scott Anderson, of Sheffield, who has been investigating an electrical process for preserving timber, is shortly going to India to carry out tests for the Indian Government, who have recognised the process as one of enormous value to the industries of the country.

Mr. W. Betterton has resigned his position with the Glacier Metal Co. Ltd., and has become managing director of a new company which has been registered under the style of the Universal Die Castings and Metal Co. Ltd., the offices of which will be at 7-9, Farm Lane, Walham Green, London, S.W. 6.

The death is announced of **Mr. Thomas Wright,** late general works manager of the Dowson-Mason Gas Plant Company Ltd., Levenshulme, Manchester, and recently partner in Smeeton-Wright Furnaces Ltd., 56, Victoria Street, London, S.W.1. Mr. Wright was a member of the Institution of Civil Engineers, of the Institution of Mechanical Engineers, the Iron and Steel Institute, and the Faraday Society. He had been recognised for many years as an expert in the construction of coal and gas-fired furnaces.

Messrs. **William C. Jeary** and **Horace F. Marchant** are carrying on the business of The Shore Leader Company, Waterloo Works, Lanfranc Street, Westminster Bridge Road, London, S.E.1.

The Harland Engineering Company, of Manchester, Glasgow, and London, has acquired a controlling interest in the British Electric Plant Co. Ltd. The works at Alloa are being reorganised to meet post-war conditions, and with the introduction of new machinery of the latest type it is hoped to effect a material increase in output in due course.

In consequence of the retirement of Mr. A. F. Halstead from the post of manager and secretary of Messrs. Beyer, Peacock and Co. Ltd., Gorton, Manchester, **Mr. A. C. Rogerson, A.M.Inst.C.E., M.I.Mech.E.,** has been appointed general manager, and **Mr. J. H. Travis** has been appointed secretary. **Mr. E. S. Luard,** 15, Dean's Yard, Westminster, is now the London representative of the firm.

Mr. J. E. Edmundson, A.M.I.E.E., who for the last 13 years has acted as engineer and manager to the Urban Electric Supply Company, Grantham and Stamford, has been appointed engineer and manager at the Hawick branch of the same company. He is to be succeeded by **Captain F. H. Brandreth, A.M.I.E.E.,** who for the last seven years has been resident engineer to the same company at Stamford.

The firm of **John Thompson,** of Ettingshall Engineering Works, Wolverhampton and Dudley, which was established in 1840, has now been reorganised and formed into four limited companies :— John Thompson (Wolverhampton) Ltd., manufacturing Lancashire boilers and welded work; John Thompson, Water Tube Boilers, Ltd., for the manufacture of water-tube boilers; John Thompson, Motor Pressings, Ltd., motor frame pressings and general pressed work; and John Thompson (Dudley) Ltd., general construction work, steel chimneys, etc. An interesting feature of the reorganisation is that the heads of staff of the various departments have been brought on to the directorate of the various companies.

in this case, assuming we are to maintain a uniform velocity of V ft. per second are W the load and ω the friction in the machine, the inertia of the moving parts not entering into the problem when uniform speed is considered. If, then, we provide a braking effort Q at the brake rim just sufficient to balance the load W, taking into account the reversed efficiency of the machine, we shall have opposed the external forces tending to accelerate the load, and thereby maintain a uniform speed.

Let ρ = the velocity ratio of the machine.

μ = the forward efficiency.

μ_1 = the reversed efficiency.

Then $Q = \frac{W}{\rho} \times \mu_1$ and $\mu_1 = 2 - \frac{1}{\mu}$.

Now we come to the second part of the problem, using the following notation :—

r = radius of weight circle at centre of gravity.

W = total revolving weight.

V_1 = velocity at radius r at critical speed.

V_2 = velocity at radius r at limiting speed.

P = total pressure of weights on brake rim.

c = coefficient of friction between rubbing surfaces.

g = gravity acceleration.

Then $P = \frac{Q}{c}$, and by the general formulæ $= \frac{WV^2}{gr}$.

We must bear in mind that the brake must not come into action within ordinary hoisting speeds, and therefore some restraining force, usually springs, must be brought into play to absorb the centrifugal force in the weights up to the speed at which we require the brake to come into action which we will term the critical speed. At this point the brake must begin action and must develop the full braking effort Q at the limiting speed.

Then the increase in centrifugal force of the weights W between the speeds V_1 and V_2 must be equal to P and

$$P = \frac{Q}{c} = \frac{W(V_2^2 - V_1^2)}{gr}$$

$$W = \frac{Qgr}{c(V_2^2 - V_1^2)}$$

Having found the total weight, this should be divided by the number of weights employed and the size of springs calculated. From the foregoing remarks, these must be capable of holding the weights up to the critical speed, and if S is the compression in the springs, then

$$S = \frac{WV_1^2}{gr}$$

this should again be divided by the number of springs. The springs should be capable of adjustment so that they may be set accurately in the test. A convenient method of testing is to rig up the brake on a spindle between two bearings and drive through a coupling from the motor. The casing may be held by an attachment to the feet, to a spring balance suitably arranged in a similar manner to a Prony brake.

DRAWING OFFICE MATERIAL.

The annual general meeting of the Drawing Office Material Dealers' Association was held on January 21st, at the Euston Hotel, London. In order to describe the functions of the organisation more precisely the name was changed to the Drawing Office Material Manufacturers' Association. Mr. W. Monkhouse (Messrs. J. Halden and Co. Ltd.) was re-elected president, and Mr. E. H. Hickman (Messrs. Norton and Gregory Ltd.) was re-appointed vice-president.

The annual report, which was signed by the president and by the secretary (Mr. Alfred W. Foster), referred to the restrictions placed upon the import of paper and papermaking materials, which brought about a diminishing supply of body paper for ferro-prussiate and ferro-gallic paper, while at the same time the demand greatly increased owing to the multiplication of Government requirements. The Council were able to exert influence in the necessary quarter which secured the issue of special import licences for materials, and placed this branch of the industry in a satisfactory position. In the same connection, in order to assist the Government by reducing the demands on shipping tonnage as much as possible, the Council arranged a voluntary agreement for the reduction of the substance of the paper used for this purpose, and for this action received a formal expression of thanks from the authorities. The Council's relationship with Government Departments has not, however, been limited to action connected with war-time restrictions, but has extended to preparation for the reconstruction period; and with a view to assisting British enterprise to take the place of foreign industry, negotiations have been proceeding with the Ministry of Reconstruction as to a possible central factory for the production in this country of the requisite supplies of drawing instruments. These negotiations are still pending, and much will depend upon the extent to which the Government is prepared to assist the scheme. So far as the Council is concerned, no pains will be spared to bring the matter to a satisfactory conclusion and, in their opinion, the whole trade, down to the smallest members, should be invited to take a financial interest in any such scheme.

Turning to that side of the Association's work which is concerned with the normal operations of industry, it is confidently claimed that the success of the first year's work has amply justified the policy on which the Council has proceeded. The future stability of British commerce depends largely on the reconciliation of what in former times were regarded as conflicting interests, and the Council has acted continuously on the assumption that close contact between the different sections of industry would lead to co-operation for mutual benefit. The success of this policy has been evidenced to members by the series of price circulars issued during the year, in which, by joint agreement between manufacturers and dealers, a proper margin of profit has been secured in respect of tracing cloth, photographic material, woodwork, and other articles which they have been able to standardise. The Council regards the amicable relations thus established between members and associates as a matter of the utmost importance,

and as affording ground for hope that a working alliance can be set up for trade purposes after the war.

It is explained that associate membership of the Association affords an opportunity for joint action between manufacturers and the trade, and this system is to be extended in another direction by the creation of sectional membership. The first section to be founded will be that of photo printers, which is already assured of adequate support, and further sections can be established as necessity arises.

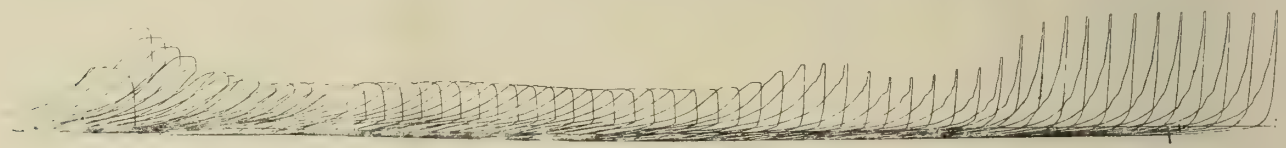
THE UNAFLOW STEAM ENGINE.

By D. H. Yates.

(*Continued from page 148.*)

Continuous Indicator Diagram.

Fig. 9 shows an actual continuous indicator diagram taken from a Unaflow engine driving a Lancashire weaving shed, and covers the period of time from starting with the clearance-space valves open to the attainment of full speed with the clearance-space valves closed. The clearance volume in this case is approximately 18 per cent, which accounts for the low-compression pressure with the clearance-space valves open. This illustrates very clearly the changing conditions.



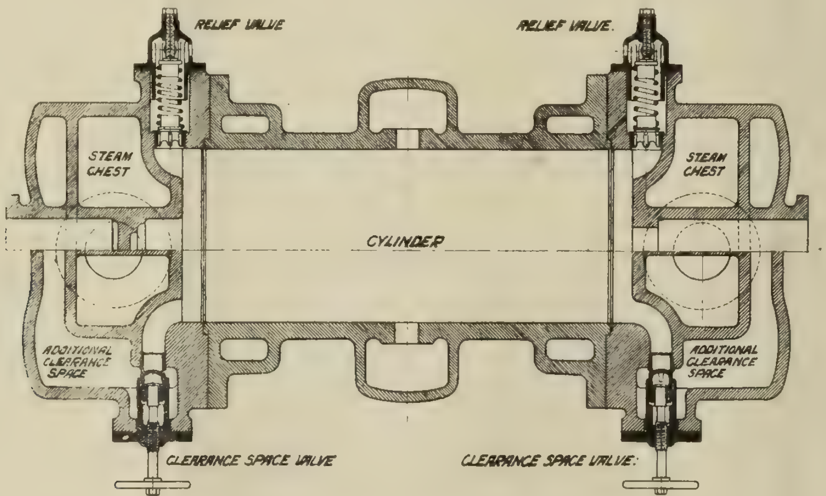
Unaflow Steam Engine.—Fig. 9.

Clearance Space Valves.

The clearance space valve may be either a simple hand-operated valve as shown in Fig. 10, or hand-operated with an arrangement for automatically opening the valve immediately the compression pressure gets higher than the initial steam pressure; for example, due to the failure of the vacuum, the opening of the valve thus automatically provides the large clearance space necessary under these circumstances. The hand-operated valve merely consists of a flat-seated screw-down valve, having the screw thread on the spindle where it passes through the valve bonnet, the valve being attached to the inner end of the spindle.

The Musgrave Valve.

The Musgrave automatic clearance-space valve is shown in Fig. 11, and consists of a flat-seated valve A attached to the spindle B by means of a screwed bush. After passing through a labyrinth packing bush formed in the cover, the spindle is shouldered down to take a spring-holder. Between this bottom spring-holder and the top one, which latter is rigidly held to the valve cover by means of the adjusting screws and lugs shown in the plan view, and through which the spindle slides, there is inserted a compression spring marked C. The spindle then passes through the cap on the cover and through the centre of a wedge marked D, which has an elongated hole to accommodate its movement when operating.



Unaflow Steam Engine.—Fig. 10.

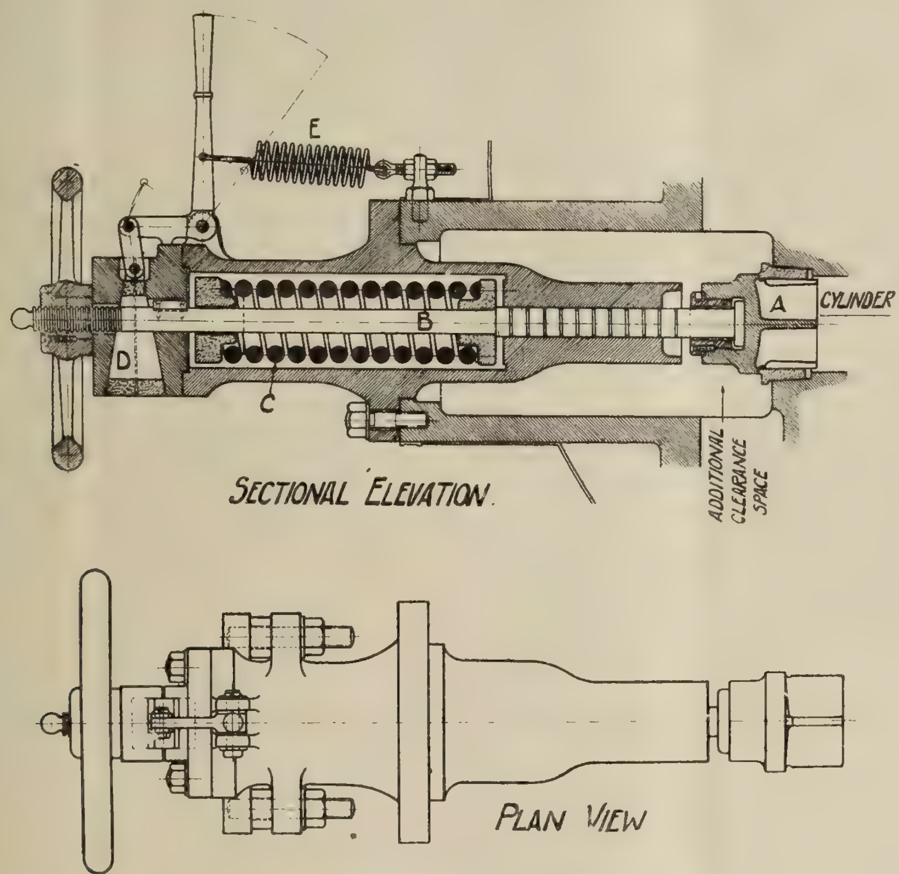
Clearance Space.

The supplementary clearance space is clearly shown in Fig. 10, together with its connection to the cylinder by means of the valve and passage. This figure also shows the spring-loaded relief valves, one of which is placed in each valve box, with the connecting passage in the cover face.

The spindle then passes through a clearance hole in what might be termed the wedge cap, and thence through a screwed bush in the hand-wheel. Attached to the wedge by means of a bell crank lever and links is a tension spring E. The action of the valve is quite simple. A few turns of the hand-wheel either opens or closes the valve, as the case may be,

without disturbing the wedge and its attachment, which is held in position by the compression load on spring C. Suppose now that the engine is running fully loaded, and by some unforseen circumstances the vacuum fails. This, then, immediately increases the final compression pressure to a large extent, with the result that as soon as the pressure gets 10 lbs. above boiler pressure, to which pressure the spring C is correspondingly loaded, the valve is lifted off its seat by the further compression of the spring with increased load. The opening of the valve then connects the cylinder with the additional clearance space and enables the engine to keep on working as a non-condensing engine, provided an automatic atmospheric exhaust valve is connected to the exhaust pipe. Immediately the valve is lifted off its seat, with the consequent movement outwards of the spindle and hand-wheel, the load is taken off the wedge cap, and the spring E, operating through the bell crank lever and links, draws up the wedge D, which keeps the valve open until released. When normal conditions are resumed the valve may again be closed by simply pulling the bell crank lever outwards, the wedge resuming the position shown in the diagram, and the spring C closes the valve, the load on C now being greater than the load on the valve.

In practice it is not found absolutely necessary to adopt this automatic valve, as the present-day condensing plant is very reliable, and a sudden complete failure of the vacuum except by a serious breakdown is practically unknown. A case of partial failure of the vacuum would show itself in the vacuum gauge and probably also by the blowing-off of the relief valves, which latter would command immediate attention. Also, upon starting up, the opening and closing of the clearance-space valves becomes as much an automatic duty of the engine attendant as does the opening and closing of the steam and injection valves. Some people, however, prefer to have the automatic clearance-space valve, as the adoption of this makes the engine absolutely fool-proof in this respect when starting up. Others prefer the hand-operated valve, as any failure in the vacuum would probably show itself sooner by means of the relief valves in case it was not noticed on the vacuum gauge.



Unaflow Steam Engine.—Fig. 11.

(To be continued.)

A NEW THEORY OF PLATE SPRINGS.

By David Landau and Percy H. Parr.

(Continued from page 149.)

We built approximately the same number and the same kind of springs as those mentioned previously, but having one important difference: all of these series of springs were built with leaves that were practically "nipless"; in other words, the leaves were so curved that when laid one against the other, without any pressure being applied, the adjacent leaves touched practically everywhere along their entire length, or they were (in shop parlance)

"dead." There were, therefore, no initial flexural stresses in these springs.

These nipless series of springs were then placed in the endurance-testing machine, with the expectation (by those not acquainted with our theories) that several leaves would break at once, and that the fractures would occur in various positions in the springs. What we did obtain was a surprise! All the nipless springs broke the short leaf first, just the same as before!—although one very noticeable difference was found: namely, that the number of vibrations required to cause fracture was increased. This latter result might, of course, have been anticipated *a priori*, but that the short leaf should continue to break first, and with such repeated insistence, was a great surprise to those who were not acquainted with the new theories which the present paper expounds.

Many other experiments were made, but one only is of interest here. In a series of springs, all the leaves above the shortest were made of plain carbon spring steel; the shortest leaves alone were made of high-grade alloy-steels (silico-manganese and chrome-vanadium were used in alternate tests). The endurance results showed that, while the number of vibrations required to cause breakage was somewhat increased, the short leaf persistently continued to fail first.

These facts, constantly shown by the endurance-testing machine, and so often confirmed from obser-

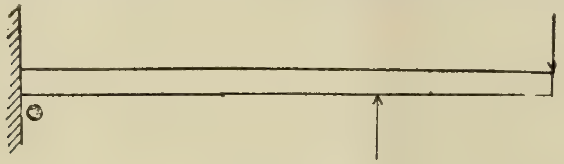


Fig. 6.

vation of leaf springs in practice, together with the fact that it has been found necessary in railway as well as in automobile practice to adopt a "constant" in the ordinary formula for the strength of leaf springs which allows for a very nominal working stress, all indicated the necessity for a new analysis, of quite a different character from that of the academic tests. It is this new analysis, the result of several years of investigation, and of continued experimental work and practical application, which we now publish for the first time.

The new theory has one important element in its favour—it explains exactly everything that has needed an explanation; analyses fully and completely the minute details of the behaviour of each leaf and the stress at every point in the leaves; predicts with certainty the endurance of each leaf comprised in a spring. It has explained, easily and consistently, each and every one of the numerous apparent inconsistencies shown by the many tests which have been made, and also the results found "on the road." It has enabled us to build springs having a far greater endurance than those designed on the basis of the old theory, and experience indicates that we can expect to obtain even better results in the near future.

The New Theory of Leaf Springs.

If a series of laminæ having the form of a cantilever, and having equal widths and equal or different thicknesses, be assembled so as to form a leaf spring, and such spring be loaded in the usual manner, it will be found that each leaf touches the one above it only at the point of encastrèment and its extremity. This may readily be shown theoretically, and is obvious in practice, as will be admitted by all who have examined the wear on spring leaves which have been in use for some time—it being understood that leaves with ordinary non-tapered ends are here being considered, and not the special cases to be considered later of the tapered leaf spring. The relations given in this exposition refer primarily to "square point" leaves; we have made elaborate investigations of the effects of tapered points, but these are to be treated in another paper; the present paper is intended to deal mainly with the fundamental relations.

Any leaf of a spring except the short plate may be considered as a beam, encastrè at one end, loaded at the other, and having a flexible support somewhere between the point of encastrèment and that of application of the load, and this is the fundamental assumption on which our new theory of leaf springs is based. This fundamental principle is illustrated by Fig. 6; its adoption leads to many special and interesting relations, a few of which we will proceed to develop.

Let l = the half length of the short leaf for a semi-elliptic spring, or the length for a cantilever spring; l_2 that for the second leaf, etc., so that l_n is the length for the nth leaf;
M = the bending moment at any section;
I_n = the moment of inertia of the section of the nth leaf;
E = the modulus of direct elasticity of the material;
W_n = the reaction, or pressure, between the end of the nth leaf and the $n + 1$th leaf;
x = the distance of any section under consideration from the point of encastrèment;
y = the deflection at any point; and
b_n = the deflection at the end of the nth leaf where W_n acts.

The fundamental relation between the curvature (in ordinary cases) and the bending moment is well known to be:—

$$EI\frac{d^2y}{dx^2} = M \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

(*To be continued.*)

FOUNDATIONS.*

By W. H. Latham.

All foundations may be included in one definition. They are independent structures, interposed between the supporting ground and an applied load. The applied load may be a backyard wall or a New York skyscraper; of a 6 in. × 3 in. stanchion or a cantilever bridge. The object of the foundation is the same in all cases; namely, to provide a safe and convenient surface on which the structure proper may be erected. The foundation, therefore, must be able (*a*) to carry the applied load without risk of cracking or undue settlement (*b*) to provide the necessary stability against wind pressure, and its

* Paper read before the Institution of Civil Engineers.

upper surface must be brought to such levels and positions as may be required by the superposed structure. To prevent cracking the stresses in the foundation must be kept below certain values depending on the material.

To prevent settlement, the pressure between it and the actual surface of the earth must be kept below a value depending on the nature of the ground and the depth of the foundation.

The provision of lateral stability is a special matter; the finishing of the surfaces is a practical matter; both these will be dealt with later. In nearly all cases, foundations are placed below the ground level. One reason for this is that the safe load on the ground increases with the depth. Other reasons are to prevent the scouring action of rain, and to guard against frost.

Theory of Foundations.

The theory of foundations is still very imperfect. The ordinary formulæ of applied mechanics are

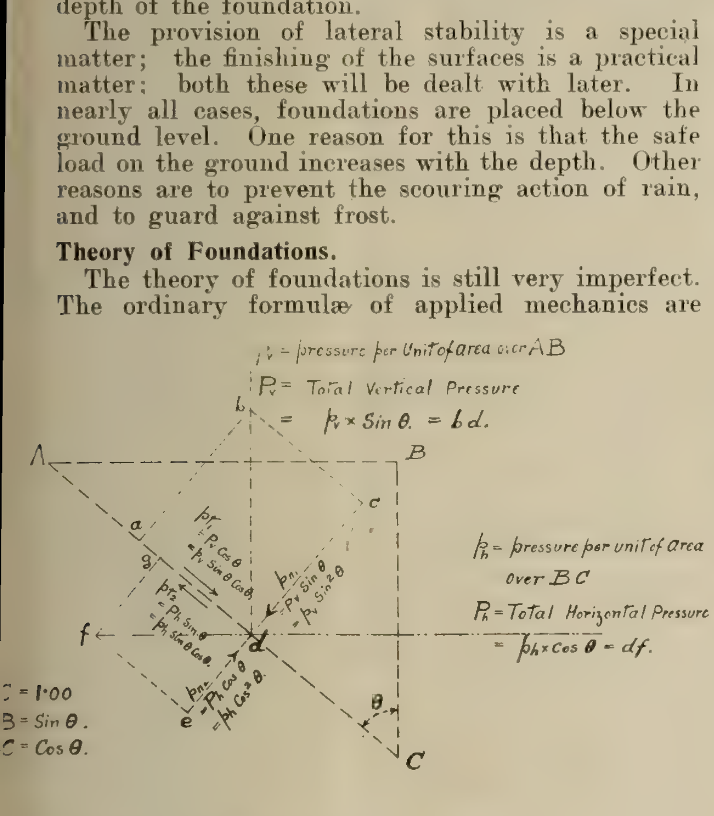


FIG. 1.

designed for materials having the following properties:—Tensile strength, compressive strength, and shear strength; elasticity in tension, compression, and shear.

These properties are found in rocks, and therefore fairly definite calculations can be made for foundations on rock surfaces. Gravels, clays, shales, and sands, however, show very differently; the elastic properties are practically absent. The tensile and shear strengths are too small and irregular to take into account, and the calculations for these materials are based on two other properties, namely, the weight per cubic foot, and the angle of repose.

Angle of Repose.

If a rectangular box with a small door in the bottom is supported above the ground and filled with small coal, gravel or sand, then on opening the door the material will run out of the box and pile itself in a rough cone or pyramid on the ground below, but it will not all run out of the box. When it has stopped running, we shall find the box bottom still covered by the material, its upper surface sloping away from the door edges at an angle which is fairly constant for any given material, and if we measure the angle of the cone or pyramid below, we shall find that it, too, slopes at this same angle, which is called the angle of repose for that material.

The Rankine Formula.

The Rankine formula (Fig. 1) assumes that the material has a definite angle of repose or coefficient of friction, but no cohesion.

In a mass of material subjected to a vertical pressure pv per square inch and a horizontal pressure ph per square inch, consider the equilibrium of a wedge ABC where AB is horizontal, BC is vertical, and the angle ACB is θ; the side AC being taken as unity.

The total vertical pressure $Pv = pv \sin\theta$.
The total horizontal pressure $Ph = ph \cos\theta$.

Resolving these pressures along and at right-angles to AC, Pv gives a normal pressure $pn_1 = pv \sin^2\theta$ and a tangential pressure $pt_1 = pv \sin\theta$ towards C.

Ph gives a normal pressure $pn_2 = ph \cos^2\theta$ and a tangential pressure. $pt_2 = ph \sin\theta$ towards A.

The normal pressures are both of the same kind, and therefore the total normal pressure

$$= pv \sin 2\theta + ph \cos^2\theta.$$

The tangential pressures are of opposite kinds, and the nett tangential pressure

$$= pv \sin\theta\cos\theta - ph \sin\theta\cos\theta$$

or

$$= (pv - ph)\sin\theta\cos\theta.$$

When $e = 45^\circ$ the angular coefficients have their maximum value and

$$pn = \frac{pv\,\theta + ph}{2}$$

$$pt = \frac{pv - ph}{2}$$

Now, if pv and ph are unequal, their resultant will be inclined to the normal, and for stability this inclination must be less than the angle of repose.

That is $$\frac{pt}{pn} \overset{<}{=} \sin A.$$

If $\frac{pt}{pn} = \sin A$ the latter will be $= \frac{pv - ph}{pv + ph}$ and

$$pv \sin A + ph \sin A = pv - ph.$$

$$ph + ph \sin A = pv - pv \sin A.$$

$$ph\,(1 + \sin A) = pv\,(1 - \sin A).$$

$$ph = pv\,\frac{1 - \sin A}{1 + \sin A}.$$

(To be continued.)

There has just been launched from the yard of the Caledon Shipbuilding and Engineering Co., Dundee, the first of a series of nine vessels which are being constructed by order of the Shipping Controller. Designed essentially for coasting trade, each vessel will have a deadweight carrying capacity of about 1,900 tons, with an overall length of 281 ft.; breadth, moulded, 38 ft.; and depth, moulded, of 18 ft. The builders are themselves supplying the engines, of triple-expansion type. Under sea-going conditions, the new vessels are to have a speed of from 12½ to 13 knots.

DIESEL ENGINE USERS' ASSOCIATION.

Mr. Napier Prentice, A.I.E.E., engineer and manager to the Suffolk Electricity Supply Co. Ltd., has been re-elected president of the Diesel Engine Users' Association for the current year, and Mr. Percy Still, M.I.M.E., chief engineer and manager to the Chelsea Eelectricity Supply Co. Ltd., has been re-elected honorary escretary.

The Association was founded in 1913, and in his annual report, the honorary secretary referred to the rapid growth of its membership, which now includes about 200 subscribers. As this includes several members scattered over the greater part of the world, and who cannot possibly attend the meetings, it is evident that the reports of proceedings and other information circulated by the Association are appreciated and found useful.

In consequence of war-time conditions, the use of tar oil as a home product suitable for fuel in Diesel engines became recently a matter of importance and urgency, and several meetings during the past year were taken up with the consideration of questions concerned with the qualities of tar oil most suitable for the purpose, and various methods of burning tar oil in Diesel engines.

The Heavy Oil Engine Fuel Committee, consisting mainly of members of the Diesel Engine Users' Association, was formed in January, 1918, to assist the Mineral Oil Production Department of the Ministry of Munitions in the control and distribution of supplies of fuel oil, and in arranging as far as possible to substitute tar oil fuel in place of imported petroleum fuel oil.

The last two meetings of the year were taken up with the consideration of the subject of Semi-Diesel Oil Engines, and as a result a very considerable amount of valuable information was collected and published in the reports of proceedings of the Association.

HYDRO-ELECTRIC POWER IN CANADA.

The Board of Trade have received two reports by the Consulting Engineer to the Commission of Conservation of Canada on the power supplies of the St. Lawrence River and Niagara Falls, and a report from the Hydro-Electric Power Commission of Ontario on the relative cost of coal and electricity for heating purposes. All these reports emphasise the actual and prospective shortage of water power for electrical generating plants in Ontario.

The St. Lawrence River.

In his report on the "Power Possibilities of the St. Lawrence River," the Consulting Engineer to the Commission of Conservation says:—

The water powers of the St. Lawrence River are, as yet, largely within the control of the people. There is, however, a shortage of hydro-electric power which is being keenly felt both in Canada and the United States, and strong efforts are being made by private interests to obtain control of the enormously advantageous power in, and adjacent to, the international boundary waters. The city of Montreal and vicinity are well supplied with electric energy but, comparatively speaking, the rates are high. If more energy were available at considerably lower rates, electric power and light would be much more extensively used both in factory and home. If large supplies of electric energy be made available at low rates, rigid inspection should be enforced to prevent extravagant and wasteful use.

There has been great shortage of power for supplying municipalities in Eastern Ontario. At the present time, the hydro-electric power Commission of Ontario has urgent requests from such municipalities at Brockville, Prescott, Winchester, Chesterville, Cornwall, Mille Roches, Smith's Falls, Perth, Carleton Place, Kemptville, and Almonte for electric power to take care of connected loads aggregating from 15,000 to 20,000 H.P., with a present peak load of not less than 8,000 H.P. Although Eastern Ontario is not so extensively engaged in manufacturing as South-Western Ontario, it is well to recall that in the autumn of 1910, when the Ontario Hydro-Electric commenced operating its Niagara system, it was supplying only about 8,000 H.P. On this system alone, in December, 1917, it was supplying more than 100 municipalities with over 200,000 H.P., and, in addition, some 50,000 H.P. is supplied to munition plants in the Niagara district.

Acute Shortage in Eastern Ontario.

The power shortage in Eastern Ontario is acute. It had been hoped that power would have been available from the large development at the Cedars on the St. Lawrence River, but this power, although conveyed through the territory of the municipalities requiring power was taken *en bloc* to the works of the Aluminium Company of America, situated at Massena, N.Y. Notwithstanding the suggestion that the needs of Canadian municipalities might be supplied by power brought back from Massena to Canada, this has not been done, but, instead, it is being sold to municipalities in the northern part of New York State. Great industrial advantage has followed the utilisation of this power generated in Canada and exported to the United States.

During recent hearings, conducted at Niagara Falls, N.Y., and elsewhere, by the Committee on Foreign Affairs of the House of Representatives, two points were prominently emphasised by representative citizens; first, that the United States could not afford to permit the removal of industries to other countries to secure cheap power; and, second, that industries requiring large blocks of power were often compelled to go where they could get it. The United States has already lost industries to Norway and to Canada. There is very strong opposition, especially throughout Ontario, to any policy which permits our exportation of electric energy required for use in Canada.

Coal Situation.

As never before, the public interest has been aroused respecting both its fuel supply and its increasing dependence upon hydro-electric energy. The central portion of Canada depends upon the United States for its coal, and war conditions are driving home to Canadians the tremendous gravity of their position. The extent to which electric energy will be available for heating has been much over-rated and, realisir·· the underlying physical limitations, one cannot be enthusiastic respecting

the extent to which it will be utilised. Of course, where large blocks of power are available at low rates, some will doubtless be so used. The availability of such power accounts for the establishment of large electro-chemical industries at Niagara and other centres, but, when the demand for power for municipal and small manufacturing purposes becomes more urgent, such works will probably be forced to leave present sites. Manufacturers and others who are ready to pay from 50 to 100 dols. per electric horse power year will not readily submit to industries utilising the coveted power at rates of from 10 to 20 dols. per horse power.

St. Lawrence River Situation.

There has been a marked general tendency to exaggerate the quantities of water power capable of development. Tentatively, however, let us assume that practically the full low-water flow of the St. Lawrence River is available for power development. Power development on this river cannot, however, be properly considered apart from the subject of the ice menace. Too great caution cannot be exercised before attempting to harness natural forces of such magnitude as exist in the flow of the St. Lawrence River. Too radical a disturbance of the balance which Nature seeks to maintain may cause disaster, and it is well to emphasise these aspects of the problem, for they involve the weighing of basic physical factors of paramount importance. If large developments should take place, considerable quantities of power would probably, for a time at least, be utilised by electro-chemical industries. With such large power users, the tendency of vendors of electrical energy is to stipulate that such customers must curtail consumption whenever the supply of generated power is reduced owing to unavoidable causes. By means of such contract arrangements, the requirements of municipalities and of industries requiring smaller amounts of power continuously, may be safeguarded.

(*To be continued.*)

Trade Items, Notes, &c.

The Suffolk Iron Foundry Co. Ltd. has purchased a piece of land of 2½ acres adjacent to a railway siding in Stowmarket, on which it is its intention to erect a modern iron foundry with up-to-date appliances. It is hoped to have this new factory running during the present year.

The Minister of Munitions gives notice that, following on the withdrawal on 31st January of the certain subsidies on steel, the drawbacks payable to the Government in respect of exports of steel have been reduced as from 1st February. Particulars of the reduced rates of drawbacks may be obtained on application to the Ministry of Munitions Steel Department (Room 104), Hotel Victoria, W.C. 2.

First Sea Trip of Concrete Steamer "Armistice."—Although only launched on January 6th, the S.S. "Armistice" has already been completely fitted out, and sailed on February 6th on her trial trip from Barrow to Belfast, where she will pick up her first cargo. Designed on the well-known Mouchel-Hennebique system, this vessel of about 1,200 tons deadweight capacity was built in the yard of the Ferro-concrete Ship Construction Co. Ltd., at Barrow-in-Furness, a firm in which Messrs. Vickers Ltd. are largely interested.

A large cyanamide factory is to be put up on the site of the old West Cumberland works at Workington, the St. Helens Coal and Firebrick Co. having been acquired by the Nitrogen Products and Carbide Co. The fertiliser is to be manufactured from carbide and atmospheric nitrogen, for which purpose some 120,000 H.P. will be required. The estimated coal consumption of the works is 3,000 tons a day, and the plant is to be completed in two-and-a-half years.

Iron and Steel Prices.—The Ministry of Munitions announces the following corrections in Press Notices which have recently been issued :—Notice No. 29, January 27th, 1919, and Notice No. 30, January 20th, 1919 : The prices for steel plates, sheets, etc., ⅛ in. thick and upwards apply to home trade only. The export prices for these descriptions of steel are as stated in Schedule Ex. 2. List of Export Drawbacks, Ex. 5 : The drawbacks on steel plates ⅛ in. thick and upwards, supplied from re-rollers, is nett, and not subject to any deduction for f.o.b. charges, etc.

Exploitation of Waterfalls. Proposed prior to the war by a Belgian company, the proposal to utilise the Imatra waterfalls, for the supply of electric power to Petrograd, has just been taken up again by a new company which was submitted a request for a concession to the Finnish Government. The costs, which were previously estimated at from 30 to 37½ million francs, will be tripled, or even quadrupled, according to the latest calculations. The most important fall has a fall of 21 metres at low-water mark, and it is estimated that it could supply a power of no less than 118,000 H.P. It is intended to utilise these falls for the creation of a national nitrogen and artificial manure industry. A further project is also on foot to exploit the waterfalls at Vuoksen.

Decline in the Austrian Coal Industry.—According to reports issued by the Austrian Ministry of Labour, which, unlike the Imperial German Authorities, did not cease the issue of statistics during the war, a sharp decline has taken place in the production of coal during 1917-18. From the 1st of January up to the end of August, 1918, the quantities of coal dispatched amounted to 97.8 million double cwts. pit coal, 15.2 million double cwt. coke, and 137 million double cwt. lignite or brown coal, or a decline for the same period of 1917 of 12.5, 2.2, and 5.3 million double cwt. respectively. The production of the former years was as follows, in double cwts. :—

	1913.	1914.	1915.	1916.
Pit coal	164.60	154.00	160.80	176.02
Coke	25.84	21.90	19.07	25.85
Lignite	273.78	237.72	220.30	232.00

Letters to the Editor.

The Editor will always be pleased to hear from readers who desire to express their opinions upon engineering and kindred subjects. Letters should be as brief as possible and be written upon one side of the paper only. The insertion of a letter in our columns does not necessarily mean that we endorse the opinions expressed therein.

LABOUR UNREST AND THE INDUSTRIAL COUNCIL.

To the Editor of "The Industrial Engineer."

Sir,—Having occupied a prominent position for many years in connection with one of our greatest and most complex industries, and having been associated with a notable agreement which was entered into 26 years ago, and which has been of inestimable benefit in promoting industrial concord, I submitted to the Government in 1911 a scheme, with the names of its supporters, which had the approval of many of the greatest captains of industry and labour leaders in the country, the result being that an Industrial Council was appointed by the Government in October that year. To this body was deputed by the Government the holding of an enquiry into industrial agreements and their observance.

The enquiry was duly held, and and occupied the attention of some of the leading experts representing both Capital and Labour for many weeks. A Blue Book, Cd. 6953, 1913 (665 pp.) was issued containing the results of this enquiry, but for some unexplained reason this Council and its work have been completely ignored by succeeding Governments. At the outbreak of war I urged, first in private letters to the then Prime Minister and other members of the Cabinet, including the present Prime Minister, and afterwards publicly, that this body

should be at once utilised for the mobilisation of industry, which I considered strategically vital to the conduct of the war. My personal appeals were disregarded, and resolutions passed by business organisations were treated similarly. Questions in Parliament received evasive answers, and amidst the innumerable organisations appointed by the Government, and the many unofficial bodies started for harmonising Capital and Labour, the Industrial Council has been ignored.

I consider that it is my duty at this time of grave industrial unrest, to urge that the public should not only demand an explanation of the reason why the Industrial Council—a body not too large, consisting of experienced representatives of organised Capital and Labour in the staple industries, should have been set aside; but also, why it is not now called upon to take up the duties for which it was appointed, and for which it was so thoroughly qualified by the practical experience of its members gained in carrying on the most importat industries of the country.—I am, yours faithfully,

Charles W. Macara.

Manchester, February 15th.

Publications.

Although flour is improving in quality it is yet far from the perfect article obtained in pre-war days. **Messrs. A. R. Tattersall and Co. Ltd.,** 75 Mark Lane, London, E.C.3, are patentees and makers of a very compact little apparatus called the "Midget Mill," made in three sizes of 250 lb., 500 lb., and 700 lb. of flour capacity per hour, the power required being respectively 3, 5, and 8 H.P. This firm have issued some very interesting pamphlets regarding these mills, a notable feature being the small space in which they can be placed, together with grain-washer and all appertaining appliances. It is stated that over 1,300 of these little machines are in successful operation throughout the world, especially in the Colonies and America. Useful information is given concerning their estimated superiority over what is known as the "long system" of milling. The "Daisy" Grain Cleaner is another speciality, claiming to be a complete cleaning plant driven by a single belt, and entirely automatic in its action. Tables of dimensions and power required are given, also several copies of the testimonials from satisfied customers, showing in a number of cases that these machines have competed successfully against large mills.

A very substantial ball-bearing is described in a brochure (Catalogue No. 3) published by the **Transmission Ball Bearing Co.,** 1050, Military Road, Buffalo, N.Y. These are known as the "Chapman Ball Bearings," and are primarily designed for power transmission purposes. They are constructed to fit any of the standard hanger frames, etc., on the market, interchanging with self-oiling boxes of the same shaft size. They are very robust in construction, and are designed with an ample factor for safety, ensuring long life even under the most strenuous conditions. A double row of balls approximately one-third the diameter of the shaft is used, the load being taken at an angle of 30 deg. from the vertical, thus permitting a percentage of lateral thrust which is inevitable in line-shaft work. The bearing is securely clamped to the shaft, a split taper wedge permitting its secure locking. (This wedge also allows for any commercial variations in the sizes of shafting.) A means of lubricating is provided by a set-screw, vaseline, previously reduced to a liquid by heat, and applied by means of an oil syringe or oil can, being used. It is said that very little attention is required in this respect, the inspection varying from once per month to that of once per year according to the working conditions of the bearing. These bearings may be applied to a number of purposes, such as loose pulleys, clutch sleeves, tram cars, railway carriages, and industrial cars, swing frames, etc. Some very large plants have been fitted with "Chapman Bearings," and it is stated that complete satisfaction has been given in every case, no trouble being experienced even in grinding shops and other places where the conditions are anything but ideal. In the firm's brochure No. 101 are given details of several tests made on these bearings against other types, and much information regarding the power absorbed, etc.

The Brown Hoisting Machinery Co. Ltd., Cleveland, Ohio, have issued a well-illustrated brochure (Catalogue E) concerning their specialities in cranes, buckets, and hoists for the safe, rapid and economical handling of materials. The "Brownhoist Grab Bucket" has several features which commend it to rapid and efficient working, the cutting edges being easily removed for renewal, and the shape of the spades constructed so that the shutting action of the bucket lends itself to its fullest gathering capacity. All sheaves are bronze bushed, equipped with compression grease caps, ensuring excellent lubrication. Wear in the ropes is eliminated as far as possible by fitting bronze rope-guards where required, which can be easily renewed, also by fitting sheet-steel guards in order to protect the parts from the material being handled. Another speciality, the "Brownhoist Drag-line Bucket," is well constructed, several advantages being claimed for it, the most notable being as follows: will handle efficiently large rock or sticky materials, easily repaired, entire front of shell can be renewed, the back gate requires no tripping or locking device, can be operated either in a down or up slope, and grades do not have to be finished by hand. This firm also manufactures automatic tubs, and as well as their standard article, are prepared to construct tubs or skips to order for any special purposes. The catalogue illustrates their various apparatus in operation and tabulates their weights, dimensions, and capacities, etc. Special booklets are published concerning several types of cranes, modern coal and ore handling machinery, coal and coke handling apparatus for gas-works plants, etc.

One of the finest catalogues that has come under our notice has been published by **Crofts (Engineers) Ltd., Bradford,** entitled "Power Transmitting Machinery." This well-known firm, stated to be the largest sole makers of power-transmitting machinery and appliances in Great Britain, with 40 years' experience to their credit, has compiled a catalogue consisting of 815 pages, tastefully bound, and divided into 16 sections, which deals with all descriptions of plant and apparatus appertaining to power transmission. To attempt to describe this book in detail would be useless. We can, therefore, only fully endorse the firm's statement to the effect that they believe it to be the most complete catalogue of its kind published in Great Britain (and in all probability, any other country). Not only are the various specialities illustrated, described, and in most cases priced, but there is a vast amount of information regarding transmission problems, etc., tables and data useful to engineers, and the catalogue may be regarded with advantage as a book of reference. We cannot recommend this catalogue too strongly to engineers, and feel confident that it will find a place in his reference library, to be used with success in any problems concerning power transmission.

Those who have had a "**Karrier**" **Calendar** must appreciate its usefulness, and also the excellent way it has been produced—a page for each month with large figures and an illustration of one phase or section of the manufacture of "Karrier" Lorries. The firm has a number of these calendars for distribution, and every owner and user of "Karrier" Lorries would do well to write to Messrs. Clayton asking them to send one of their calendars for 1919, which they will be very pleased to do. Calendars are scarce, particularly good ones, and those who are fortuate in getting a calendar will have something which is certainly useful.

Queries and Replies.

We shall at all times be pleased to help our readers out of their difficulties to the best of our power, and invite them to make use of this column for that purpose.

Utilising Exhaust Steam.—The writer would be glad of some advice *re* the possibility of introducing a modern steam turbine, utilising the exhaust steam from a Compound S.C. Tandem Horizontal Engine: cylinders $18\frac{1}{2}$ in. and 34 in. diameter × 36 in. stroke. The working pressure is 120 lb.; revolutions, 78; vacuum, 25 in. The steam is superheated to a total heat of 600 deg. Fah. What power might be developed by the turbo-generator under the conditions?

W. H. L. (Leeds).—We publish the first instalment of the article on "Foundations" in the current issue.

J. N. (Croydon).—Full particulars of the necessary qualifications may be obtained from the Secretary, Institution of Civil Engineers, Great George Street, Westminster, London, S.W.

The Institution of Civil Engineers.—An Ordinary Meeting of the above Institution will be held on Tuesday, February 25th, at 5-30 p.m. The papers to be submitted for discussion are: "The Flow of Water in Pipes and Pressure Tunnels," by Frederick John Mallett, Assoc.M.Inst.C.E.; and "Discharge of Large Cast-iron Pipe-lines in Relation to Their Age," by Alfred Atkinson Barnes, Assoc.M.Inst.C.E.

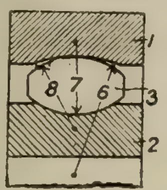
Patent Applications.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

ABSTRACTS OF SPECIFICATIONS.

BEARINGS.

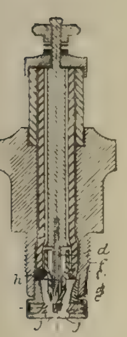
119,068.—E. C. R. MARKS, 57, Lincoln's Inn Fields, London.—(Nordiska Kullager Aktiebolaget; Hisingen, Goteborg, Sweden.)—Sept. 14th, 1917.—In a roller bearing having barrel-shaped rollers the centre of curvature of the curved producer of a roller 3 is situated in the thickness of the race ring 1 or 2, and the centre situated in the inner ring 2 is nearer to the roller than to the



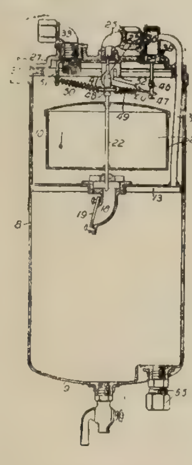
centre line of the bearing. The race grooves may have the same curvature as the rollers, or somewhat less curvature as indicated by the radius 6. The radius 7 of the inner race groove is equal to the radius 8 of the producer of the roller. The rollers tend to remain parallel to the axis of the bearing. Specification 216/88 is referred to.

SPARKING PLUGS.

119,073.—G. E. TURNBULL, 24, Reading Road, Henley-on-Thames, Oxfordshire.—Sept. 17th, 1917.—The insulation consists of silica or fused quartz. The inner portion *d* of the central conductor carries a nickel or like electrode *e* and is insulated from surface leakage by a tube *f* or sleeve *g*, the latter being retained by a washer *h* against which is screwed a ring carrying pins or screwed studs *j* serving as outer electrodes. This ring may be provided with a flange which is clamped between a shoulder on the casing and the inner end of the insulator.



Patent 11 ,073.



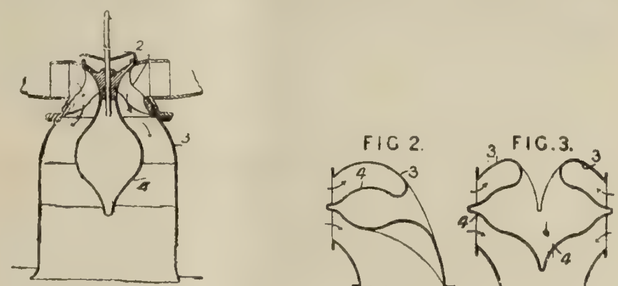
Patent 119,082.

INTERNAL-COMBUSTION ENGINES.

119,082.—E. C. R. MARKS, 57, Lincoln's Inn Fields, London.—(Sparks-Withington C .; North Street, Jackson, Michigan, U.S.A.)—Sept. 19th, 1917.—In suction-actuated liquid-fuel supply apparatus wherein fuel is raised by suction from a main tank to an intermediate tank at a higher level whence it is discharged to the carburettor, the intermediate tank 8 is divided by a partition 13 into chambers 10, 11, of which 11 is connected at 55 to the carburettor, and 10 is connected at 33 to the main fuel tank, at 25 to a source of suction, such as the engine induction pipe, and at 36 to the atmosphere. The connexions 25, 36 are provided with valves 23, 39 respectively, which are actuated by a float 26 in accordance with the fuel level in the chamber 10. The float is mounted rigidly on the stem 22 of the valve 23 and carries a disc 48 to which two springs 49, 50 are connected. The other end of the spring 50 is connected to a flange 51, and that of the spring 49 to the outer end of a U-shaped lever 40 which is pivoted to depended portions 41. This lever engages loosely the stem of the valve 39 between enlargements 46, 47 thereon and its upward movement is limited by stop 52. Atmospheric pressure is transmitted to the chamber 11 through a pipe 53. As the fuel rises in the chamber 10, the float is raised and, when the disc 48 is above the pivot of the lever 40, the spring 49 causes the lever to snap over and open the valve 39. The valve 23 being closed or nearly closed, fuel is discharged through the nozzle 18 and non-return valve 19 to the chamber 11. The float falls with the fuel level, the valve 23 is again opened, the spring 49 snaps the lever 40 downwardly to close the valve 39 and the chamber 10 is again filled with fuel. The valve 23, instead of controlling the suction connexion, may control the liquid inlet connexion 33. The cover 27 of the chamber 10 is secured by screws to a flanged ring 28, the jointing face 30 of which has two thicknesses of metal, packing 31 being inserted. In a modified construction, the partition 13, instead of being secured, as shown, by soldering, welding, etc., is inserted between flanges formed on the chambers 10, 11; the lower face 9 of the chamber 11 is flat instead of dome shape and the pipe 53 is situated outside the chamber 10.

TURBINES.

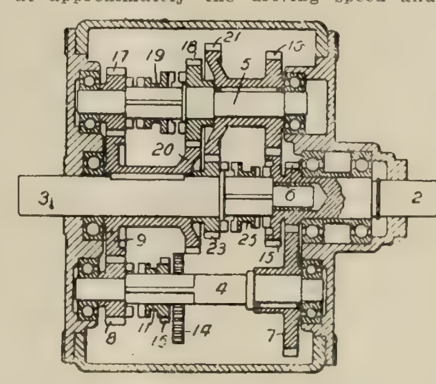
119,085.—H. O. DAHL, 60, Upplandsgatan, Stockholm.—Sept. 19th, 1917.—The outlet pipe 3 of a turbine having a runner 2 is fitted with a core 4, Figs. 1 and 2, which gradually increases in diameter



and then decreases. The core may be stationary or rotate with the turbine shaft. Fig. 3 shows a duplex arrangement having a chamber in the core 4 suitable for housing the turbine shaft bearings.

VARIABLE-SPEED TOOTHED GEARING.

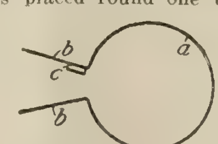
119,098.—T. A. N. LEADBETTER, Arcan, Bower Road, Hale, Cheshire, A. L. K. GILCHRIST, 50, East Beach, Lytham, Lancaster, and W. H. TATE, 7, Westbourn Grove, Barkers Lane, Ashton-on-Mersey, Manchester.—Sept. 26th, 1917.—In variable-speed gearing, two lay-shafts are driven by toothed gearing from the driving-shaft, one at approximately the driving speed and the other



more slowly, wheels loose on and clutchable to the lay-shafts being geared with wheels one less in number, on the driven shaft. The driving-shaft 2 carries wheels 6, 15, driving wheels 7, 16, secured on lay-shafts 4, 5. Loose gear-wheels 8, 17, 18 gearing with wheels 9, 20 on the driven shaft 3 are alternatively clutched to their shafts by clutches 11, 19 to give low speeds. A clutch 25 on the shaft 3 may be engaged with the wheel 15 for solid drive or with a loose wheel 23 gearing with a wheel 21 fast on the shaft 5 for a speed which may be higher than the solid drive. The reverse is obtained by bringing a wheel 15, secured to the clutch 11, into gear with a wheel 14 turning with a wheel (not shown) gearing with the wheel 9. Additional lay-shafts may be employed.

PISTONS.

119,107.—AUSTIN MOTOR CO., Longbridge Works, Northfield, Birmingham, and W. I. TOWNSEND, 3, London Road, Amersham, Buckinghamshire.—Oct. 3rd, 1917.—A tool for facilitating the insertion of a piston into its cylinder consists of a circular band of metal *a*, which is placed round one end of a packing-ring



and is contracted by means of handles or otherwise, while the other edge of the packing-ring is inserted in the cylinder. The tool shown is formed with integral handles *b* of less depth than the band *a*, one handle having a catch *c* into which the other handle can be sprung in order to hold the device in its contracted position.

INTERNAL-COMBUSTION ENGINES.

119,063.—A. J. JUNG, 7A, Princes Street, and GODWARD CARBURETTER CO., 53, Victoria Street, both in Westminster.—Aug. 17th, 1917.—In carburettors such as described in Specification 102,043, in which the air and fuel pass into an expansion chamber that is usually lined with absorbent material, and expands towards the induction pipe from the inlet for fuel and air, the air inlet to the carburettor is provided with a valve which is connected through adjustable linkage mechanism with the throttle valve.

TOOTHED GEARING.

119,109.—D. BROWN & SONS and A. SYKES, Park Works, Lockwood, Huddersfield.—Oct. 4th, 1917.—In order to reduce torsional deflection, neutralise end thrusts, and give a uniform distribution of the load in helical and other toothed reduction gearing for turbines, etc., the shaft of a long pinion is made hollow to receive an internal driving-shaft coupled to the turbine, and the driving-shaft is coupled to the pinion shaft at each end of the latter, or at two intermediate points, by oppositely directed helical or other inclined teeth. In the arrangement shown in Figs. 1 and 2, the pinion shaft *a* carrying the pinion sections *b* is driven at

FIG. 1.

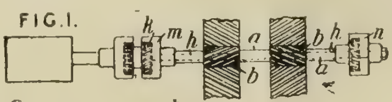


FIG. 2.

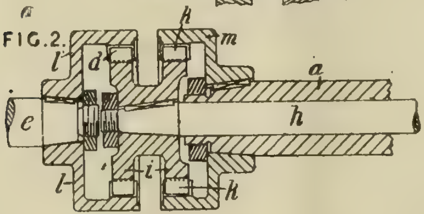
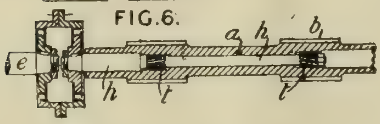


FIG. 6.



each end by oppositely inclined helical couplings *k* from the internal shaft *h*. The shaft *h*, as shown in Fig. 2, is driven from the turbine shaft *e* by a straight-toothed coupling *l*, *b*, *i* which is also provided with helical teeth *k* meshing with helical teeth in the flanges *m*, *n* keyed to each end of the pinion shaft *a*. A modification is described in which two flanges, equivalent to *i*, are coupled to two flanges equivalent to *m* by radial teeth with inclined sides. In the arrangement shown in Fig. 6, the internal shaft *h* is connected to the pinion shaft *a* at two intermediate points by helical teeth *t*. The shaft *h* may be integral with or rigidly connected to the turbine shaft.

ROTARY PUMPS.

119,130.—E. J. A. SCHULTZ, 7, Rue Scribe, Paris.—Oct. 24th, 1917.—Rotary pumping apparatus of the Roots'-blower type for delivering separately and simultaneously a number of fluids comprises a casing divided by partitions D, E into a number of chambers of different capacities having each its own inlet and outlet conduit and provided with intermeshing gear pistons *a*, *a1*, *b*, *b1*, *c*, *c1* mounted freely on parallel shafts C, C1, the driving-shaft C having loose pins *e1*, *e2*, *e3* engaging recesses in the pistons

FIG. 2

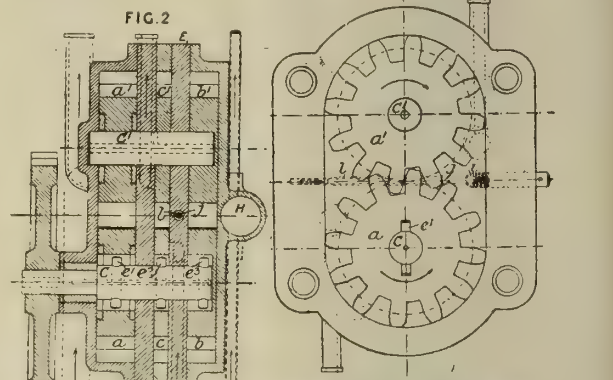
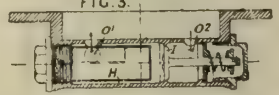


FIG. 3.



mounted thereon. The left-hand chamber may be for pumping water, the middle for pumping lubricant, and the right-hand for pumping fuel, the temperature of the lubricant being raised by its proximity to the cooling-water chamber. The fuel chamber may be provided with a by-pass H, Fig. 3, between the inlet side o1 and the outlet side o2 of the chamber, a spring-pressed valve I regulating the proportion of fluid flowing there-through. The flow of lubricant may be regulated by a by-pass *l* fitted with a spring-pressed valve *i* adjusted by a screw member *j* allowing liquid to return to the suction side. To promote the circulation of water at a small speed through a large duct, the pump may draw water by a pipe of small cross-section located in an enlargement of the duct, and return it through a second similar pipe opening also into the enlargement and situated back to back with the first pipe, the second pipe having a contracted nozzle to accelerate the flow.

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— THE —

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CONTENTS.

EDITORIAL.

THE INDUSTRIAL CONFERENCE.

To solve industrial troubles on the widest possible basis the Government have summoned 800 representatives, the majority of whom represent labour, to a Joint Council. It is hoped that this precedent will prove to be the Magna Charta of future industry; it is quite as important in its way as the first Parliament ever summoned. Some first-hand and permanent national means must obviously be supremely important as a tribunal whereby differences are composed and adjustment facilitated. Such a tribunal would ventilate grievance and bad blood; even the extremist, who too often sways passion and prejudice, would find the repression caused by calm deliberation.

Rough Equalisation.

For years past there has been some rough equalisation between employers' federation and men's trade union. The representatives of both, welded into a corporate assembly capable of binding decision, must inevitably ensure smoother and more stable conditions. If industry—all sections—becomes federated to rule its own destinies, term stability and real agreement may be reached.

It would be presumption to specify any constitution, but the logical result of the Whitley scheme is nothing less than a Parliament of Industry.

Dangerous and Impracticable Idealists.

In such an assembly the dangerous and impracticable idealist would not exercise his present influence, nor the grasping and conscienceless corporation pursue the even tenour of its way quite so undisturbed. Obviously, to a permanent legislative assembly the representatives would be elected, and it by no means follows that it would be labour and capital merely thrashing out their differences in public. Industry contains many grades, all of whom, under a rational scheme, would find representation. The employee above the manual class, who is the salt of industry, and whose reward is dependent too much upon favour and caprice, and whose pay is rarely in accord with responsibility and more general ability, would obtain a hearing now desired.

Segregated industry must become federated industry; to parley before the breaking point is in sight, instead of in the breach, has much to recommend it. There is no novelty in legislation where vast individual difference is in question, otherwise democratic government were already a failure.

If a labourer is entitled to vote for someone who will presently represent the Imperial destinies of Great Britain, he is equally as competent to help in the selection of a representative of a nearer and more realised issue.

The artisan, in most trades, is quite as intelligent as the average employer. A recent comment by a shrewd and well-known writer was that "the bulk of the employers in Great Britain appear to be men differing rather in tenacity of character than in breadth of outlook from the men they employ." The appreciation of ability or of the more general issues in industry is not confined to management, and in the new era in which we now live it is imperative to secure identity of interest, without which deplorable events will certainly ensue. One side demands, the other refuses; there is no approximation to a *via media*, to a working agreement; sectional strikes

result, which invariably cause acute and widespread distress; one side or the other wins a crushing victory at quite inordinate cost in industrial casualty, and rarely is the immediate gain worth the scars of the conflict. During the war concession after concession was made without assignment of reason, or whether it was possible to afford the new conditions as a permanent burden.

Class Organisations.

The class organisations existing in industry armed for defence or aggression were similar in all respects to the international conditions of Europe before the war. With the opposite poles charged with high potential current, a very small event will cause catastrophe. The exact cause of war is often obscure, the general reasons which tend to its outbreak are of some magnitude; the pretext for industrial strife is in similar case. Both war and strike are abnormal conditions, and the broad reason for both is want of confidence. Mutual hostility, fostered for numerous past reasons, has ranged industry into two armed camps; and the closer the identity of purpose on both sides and the greater the resources, the more overwhelming the national disaster when it occurs. The exact cause of an industrial battle is often ridiculous to mere reason, but it must be remembered that the past history of industry has been atrocious, and in the sacred name of economics vast suffering and social crime have been perpetrated.

Labour is now so organised that its power is automatic; tyranny of any kind is foreign to freedom, and this tyranny of ignorance is the worst of all. Present trouble must, however, take into consideration past betrayal. It is the restoration of confidence which is needed to rebuild national industry and give it stability, so that term agreements and contracts shall be valid and binding.

After all, industrial disputes are national tragedies, and so far from the State simply keeping the ring for the combatants, it must insist upon the national view point and give opportunity to ventilate the broad general outlines of industrial disagreement.

An Industrial Parliament.

An Industrial Parliament would provide a real safety valve where the small event which otherwise would cause disaster would take its relative place.

The proceedings of the Conference during the past week strengthen the belief that it provides the coping stone to general trouble, just as a works committee can avoid domestic trouble of a narrower order.

The national capacity for extemporisation and compromise, for finding a solution by consent through a bewildering range of complexity, is hammering out a co-ordinated scheme to knit up the ravelled threads into an industrial fabric.

Anything which will secure term stability which will once and for all put an end to industrial strife, which substitutes open debate for conditions where neither side is acquainted with the ideas of the other, is worth the full support of the real bulk of industry.

Representative government has not yet resulted in national disaster—the wider the franchise the less likely selfish aggression; every extension has caused the pessimists to prophesy vain things which have never matured. Industry has hitherto been in effect feudal in character, and no danger need be apprehended from general co-partnership and more identity of interest. Unless the Conference finds a *modus vivendi*, passes into periodical session for debate upon industrial policy, realises a policy of goodwill in place of mutual hostility, the national outlook is grave indeed. It will mean that mankind is bankrupt of expedient to cut out the parent of evils, for industry and its concerns to-day are the dominant issue which overshadows even the larger international adjustments. If it is possible to leave the world in the bonds of permanent peace, it cannot be beyond the wit of man to win industrial peace as war's legacy. In the Conference at present in session lie issues so grave and far-reaching that every citizen of the industrial world may well hope that wisdom and common sense may guide their deliberations to a happy ending.

EXCHANGE.

As commonly understood, exchange has an economic basis, and includes the terms currency, imports, exports, banking facilities, and all the machinery of credit leading to transference of marketable wealth.

Trade is the exchange of one commodity for another, and elemental barter underlies all the complex phenomena of commerce.

The operations of a railroad or those of a big corporation are in essentials the same as the business of the hawker who offers goods for discarded clothing, and, although this looks queer at first sight, it is only because the exchange is direct, not because it is different. Credit is the basis of modern trade, which is simply belief by one individual in the ability of a second to meet liabilities at a promised date.

A personal aspect of the subject is the exchange of human energy into tangible form by the payment of salary or wages, giving power to exchange this again into goods. The rate of exchange is dependent upon market exigencies, and is again a matter of barter. The operations of the law of supply and demand has much to do with the exact rate prevailing. The human body is itself an exchange this time, of energy; British thermal units are exchanged into energy just as in a boiler. The loss on transfer is due to radiation and dissipation of heat.

There are always two sides to any exchange, just as there are always two parties to a contract. There must be value received on both sides; for whether the transaction is of material, service, or less realisable matters, it obeys the law of equity that value is obtained.

Some transactions in the nature of exchange are difficult to assess, some even cannot be valued at all. Sterling honesty, impartiality, independence, and character, have a value which at any rate of exchange cannot be exactly expressed. There are again other things never exchanged, only bestowed, and possibly the most difficult because the least tangible is that sense of honour whose scruples are never for sale. Market rates cannot apply to such qualities which are valuable, precisely as no value can be set upon them.

Qualifications are more easy to assess than character, and the overall efficiency in a human sense is dependent upon qualities difficult to gauge, and indeed outside the scope of any scale or measure.

The purchase of necessity by the sacrifice of superfluity is common to every exchange; giving a square deal in the process is the basis of continued confidence, and alone makes successful commerce.

Character, confidence, reputation are interdependent terms, the exchange of the one into the other is simple evolution.

There is a sense in which honour is the only basis of trade worth while, the provision of the best possible article is something to be proud of, and exchange of this type something to glory in. With such transaction go goodwill, service, and satisfaction; it is easy to continue relations and duplicate the deal.

Exchange is universal and fundamental; its efficient discharge distinguishes engineering effort, whether this be power into product, mental activity into material result, salary into the efficient performance of duties. Since there is some sacrifice both sides, more is given than is apparent, and it is this latent part of the exchange which is the most important. There are two sides to every equation, and exchange equalises and substitutes a part to be remembered.

HEAT APPLIED TO ENGINEERING.

By Prof. W. W. Haldane Gee, B.Sc., M.Sc.Tech.

(*Continued from page 144.*)

Voltmeters.

To measure the difference of electrical pressure between the ends of thermo-couples a suitable galvanometer is required. The type usually employed is one with a moving coil. Since introduced by Deprez and D'Arsonval, moving coil galvanometers have undergone many changes in details of construction, and now are extensively in use for laboratory, scientific, and industrial purposes. Fig. 28 shows one of the mirror type of modern design. The moving coil of rectangular shape is suspended by a flat ligament of phosphor-bronze between the poles of a steel magnet. When in use the current passes from the left-hand terminal through the suspension, then around the coil to a bottom flexible spring, and thence up a copper lead to the right-hand terminal. The magnetic field produced by the magnet is concentrated by a soft-iron cylinder fixed between the poles of the magnet, so that the coil has freedom of movement in an annular space, within which is a strong and uniform radial magnetic field. A current circulating in the coil produces two equal electromagnetic forces, tending to turn the coil about its axis. The moment of this couple depends on the product of the current strength, the area of the coil, the number of turns, and the strength of the magnetic field. It is balanced by the product of the constant of torsion, and the angle through which the coil turns. It hence follows that for a galvanometer of given construction, the current is simply proportional to the deflection; in other words, the instrument follows a straight line law.

Galvanometer Scale.

The galvanometer shown in the figure being of the reflecting type, the deflection of the coil is observed by the reflection of light from a small concave mirror attached to the upper part of the coil. It is used in conjunction with a straight scale. That shown by A in Fig. 29 is of semi-transparent celluloid, divided into millimetres. It is supported by an adjustable tube B, held by the tripod C. A small electric glow lamp is contained within the lantern D, and is connected by flexible leads to a supply of the right voltage. By

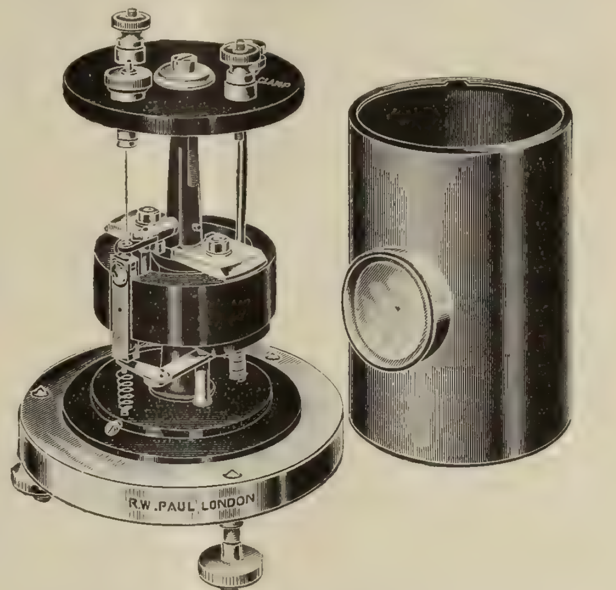

Fig. 28.—Moving Coil Galvanometer. (R. W. Paul.)

sliding in or out from the lantern a tube carrying a lens and diaphragm, with a thin wire across the centre of the latter, a bright light can be concentrated on the mirror. From the mirror the light is reflected on to the scale, and produces a bright patch of light with an image of the wire at its centre. The usual distance between scale and mirror is one metre.

Damping of Vibrations.

An important property of a moving coil instrument is that it may be readily made *dead-beat* or *aperiodic*.

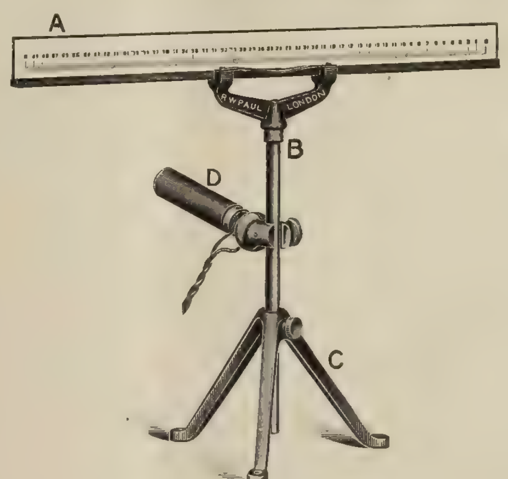

Fig. 29.—Galvanometer Scale and Lamp. (R. W. Paul.)

This is secured in the design shown in Fig. 28 by having a separate coil of copper, the ends of which can be short-circuited by the use of the screw shown. Any movement of the coil will result in the production of induced currents in the short-circuited coil in such a direction as to produce, by their magnetic action,

forces which always oppose the motion, with the result that the moving system is quickly brought to rest.

Galvanometer Constants.

The galvanometer described above will give with a galvanometer resistance of 175 ohms a deflection of one millimetre on a scale one metre distant, by a current of about 1/100 of a micro-ampere. This figure is called the sensitivity, or sometimes "figure of merit," when used as an ammeter. To find the corresponding value as a voltmeter, it is only necessary to multiply the above value by the resistance. This gives :—

$$175 \times 10^{-8} \text{ volts, or } 1{\cdot}75 \text{ microvolts.}$$

The mirror galvanometer is unsuited for general workshop use, for it most be installed in some fixed position. Should it be necessary to move it, the coil must be clamped. This may be done by the use of an arrestment operated by a milled head on the top of the galvanometer.

Pointer Instruments.

We are chiefly indebted to Weston for producing a sufficiently sensitive moving-coil galvanometer, in which the deflections are given by a pointer (see Fig 30) attached to the coil. This much more portable and convenient

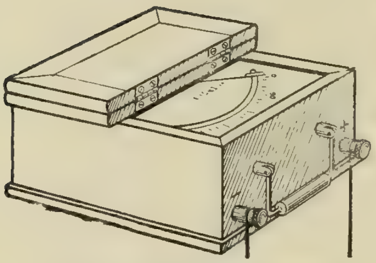

Fig. 30.—Portable Pyrometer Indicator. (Budenberg Co.)

Fig. 31.—Uni Pivot Coil. (R. W. Paul.)

type has now attained a high state of design and manufacture, which has been reached by a careful study of each essential detail. First in importance is the permanent magnet; this is usually made of a special kind of tungsten steel. The steel is hardened, magnetised, and then "aged" by raising its temperature, say to 100 deg. C. for many hours, which weakens the magnet, but renders it less liable to further decrease in strength. To the poles of the magnet it is usual to attach pole pieces of soft iron.

The movement of the coil is ensured by providing it with two fine steel pivots, which move with little friction in sapphire jewels, whilst its motion is controlled by two flat helical springs of phosphor-bronze. It is very desirable that the total length of the strip of which each spring is made should relatively be great compared with its thickness. Attached to the coil is a light pointer of aluminium, capable of movement over a cardboard scale, mounted on a metal plate. Beneath this pointer is a mirror glass, which enables the readings to be taken without causing an error due to parallax. It is a matter of importance that the case enclosing the instrument should be dust-proof.

The coil, of insulated copper wire, is wound on a light aluminium frame, in which the currents are induced that make the instrument dead-beat.

Temperature Compensation.

To compensate sufficiently well for the variation of its resistance due to changes of temperature, the moving coil is connected in series with a second fixed coil placed within the case of the instrument. This extra

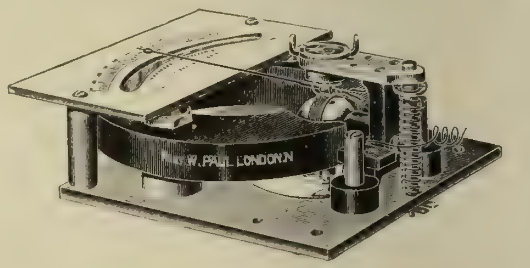

Fig. 32.—Uni-Pivot Instrument. (R. W. Paul.)

resistance, sometimes called the "swamping" coil, is made of an alloy of negligible or small temperature coefficient. Its effect can be calculated as follows :—

Let R be the resistance of the copper coil.
" R_1 " " " other coil.
" α " temperature coefficient of the copper coil.
" α_1 " " " " other coil.

If the temperature rises one degree the increase of the resistances of the coils will be $R\alpha$ and $R_1\alpha_1$ respectively. Dividing the total increase by the original resistance we have :—

$$\alpha_2 = \frac{R\alpha + R_1\alpha_1}{R + R_1}$$

where α_2 is the effective temperature coefficient of the combination.

Example 1.—Find the temperature coefficient of a copper coil of 10 ohms and temperature coefficient 0·004 in series with a resistance of 40 ohms of temperature coefficient 0·0004.

Answer.—

$$\alpha_2 = \frac{(10 \times 0{\cdot}004) + (40 \times 0{\cdot}0004)}{10 + 40} = 0{\cdot}00112.$$

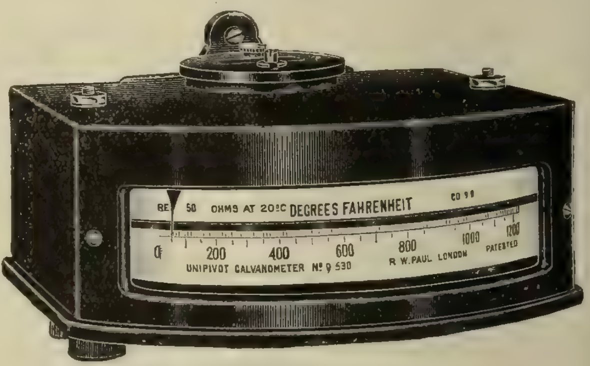

Fig. 33.—Wall Pattern Indicator. (R. W. Paul.)

Example 2.—If in the above example the rise of temperature be 20 deg. C., find the percentage change in the total resistance.

Answer.—

$$\frac{20 \times 0{\cdot}00112}{50} \times 100 = \text{less than } 0{\cdot}05 \text{ per cent.}$$

To compensate for the alteration of the torsional constant of the springs due to temperature changes, one of the control springs should be wound clockwise and the other in the reverse direction, so that the temperature changes balance each other.

All instruments with springs, ligaments, and wire suspensions are liable to have a variable zero, so that it is advisable to provide an adjustment for setting the pointer to zero. When instruments have to be moved from one place to another, as in the case of the mirror instrument, it is necessary to have an arrestment so as to fix the moving coil.

Moving-coil instruments may be constructed with a single pivot. This type is due to R. W. Paul. The details of one of his "uni-pivot" galvanometers are shown in Figs. 31 and 32. The core is spherical and the coil is circular. At the centre of the sphere is placed a jewel on which the pivot moves. A number of advantages are claimed for this uni-pivot system. These include (1) great reduction of pivot friction, (2) high sensitivity, and (3) exact levelling is unnecessary. The instrument shown in Fig. 33 is a wall pattern, with a scale of Fahrenheit degrees.

(*To be continued.*)

THE INFLUENCE OF IMPURITIES ON THE MECHANICAL PROPERTIES OF ADMIRALTY GUN-METAL.

By F. Johnson, M.Sc., Birmingham.

(*Continued from page 108.*)

Antimony.

L. Parry refers to the common practice of adding antimony to bronze, but has no experimental evidence to offer in illustration of its effects.

H. S. Primrose refers to its harmful effects, but indicates that its presence in gun-metal in harmful proportion can be attributed only to the use of low-grade tin. If, however, as much as 0.1 per cent be present, castings, with the exception of very large ones which have been slowly cooled, will not be embrittled.

H. S. Gulick attributes to antimony increase in hardness, closeness of grain, and tensile strength, with lowering of percentage elongation and conductivity, when added to copper-tin alloys.

Arsenic.

The only figures which the author has been able to trace in connection with the influence of arsenic on Admiralty gun-metal are those given by R. T. Rolfe as follows:—

Table I.

Arsenic Per cent.	Average Number of Tests.	Yield Point. (Tons per Square Inch.)	Tensile Stress. (Tons per Square Inch.)	Elongation Per cent.
trace	114	11·2	16·6	14·3
0.30	172	10·7	15·5	12·4
0·75	10	11·2	14·4	7·4

These figures indicate that arsenic has a detrimental influence, but that up to 0.3 per cent the influence is not at all serious. The drawback to this series of tests is the absence of complete analytical data. The influence attributed to arsenic alone may be shared by other impurities.

H. S. Primrose regards arsenic as "one of the fruitful sources of failure in the kinds of gun-metal made from scrap or poor grades of copper ingots." He holds that the action of arsenic in copper is a deoxidising one, but the author has shown that this is not the case. Primrose further argues that, "with larger amounts," arsenic forms a very brittle eutectic, which is "comparatively stable, and, although some of the arsenic must be volatilised when the copper is melted in making gun-metal, there is sufficient left to cause an excessive separation of the bronze eutectoid, and thus yield a very poor gun-metal."

Without a clearer definition of "larger amounts," it is difficult to discuss this statement. However, if we take 0.84 per cent arsenic as the limit, being the largest amount to which Primrose refers, we are still short of the amount required to produce the alpha + beta eutectic. It would seem, however, a correct interpretation of the action of arsenic to ascribe to it the throwing out of tin from solution in the alpha phase, thus creating more eutectoid, and hence greater brittleness. But caution is necessary here, because an increase in the quantity of eutectoid does not necessarily mean greater brittleness. It is the physical condition of the eutectoid which is of greater importance than a slight increase in its amount.

The author is not disposed to quarrel with the introduction of arsenic into Admiralty gun-metal. More important, very often, than slight lowering of tensile strength and elongation is an increase in soundness. That arsenic can act beneficially on copper from the point of view of reducing porosity, the author has proved in works practice over and over again. That it can act similarly in Admiralty gun-metal is not a rash assumption to make. E. Lewis claimed that the addition of arsenic to gun-metal was not only not detrimental, but desirable. It must, however, be clearly understood that its action is not a deoxidising one.

Bismuth.

This metal is so rarely present in reputable brands of copper in amount likely to be harmful that gun-metal made therefrom can hardly be adversely affected even in a minute degree. Primrose states that it may be found in scrap material, and that if the amount found in gun-metal should even approach 0.1 per cent the castings would be worthless. Although bismuth exerts its most deleterious effect on hot-working properties, its effect on the mechanical properties of gun-metal at normal temperatures would be detrimental, as it separates out as a brittle intercrystalline constituent, thus lowering the resistance of the alloy to both static and dynamic stresses.

Lead.

More investigations have been made on the influence of lead in gun-metal than on the influence of any other metal.

Dewrance has shown that Admiralty gun-metal in which 0.5 per cent lead had displaced an equivalent amount of copper could, unlike the lead-free gun-metal, be used without loss of strength at 550 deg. Fah. (286 deg. Cen.).

The machining properties are, as is well-known, materially improved, the turnings being shorter than in the lead-free alloy.

Sir Henry Oram, in the discussion on Dewrance's paper, quoted results (obtained by the Admiralty) which do not confirm the loss of strength of lead-free gun-metal when heated to 450 deg. Fah. (232 deg. Cen.). The figures given in Table II. show that the difference in properties between normal temperature and 450 dg. Fah. (232 deg. Cen.), both as regards ordinary 88 : 10 : 2 gun-metal and the same alloy containing 0.5 per cent lead, is only quite small.

Table II.

Temp. of Test.		Admiralty Gun-Metal. Copper 88, Tin 10, Zinc 2 per cent.		Gun-Metal with Lead. Copper 87½, Tin 10, Zinc 2, Lead ½ per cent.		Authority.
Deg. F.	Deg. C.	Ultimate Tensile Stress. Tons per Sq. In.	Elongation per cent.	Ultimate Tensile Stress. Tons per Sq. In.	Elongation per cent.	
60	15	16·4	11	16·5	8	Dewrance
400	205	9·5	1	..	..	
500	260	9·8	1·8	16·0	13·2	
550	288	..	..	15·8	18·0	
600	316	9·15	1·8	11·3	8·0	
700	371	7·0	0·25	8·25	2·0	
60	15	14·5	14·0	15·1	18·5	Admiralty
450	232	13·6	13·9	14·8	20·3	,,
450	232	9·7	1·4	16·2	12·2	Dewrance†

† Obtained by interpolation from curve. (See original paper.)

Dewrance's bars were cast nearly to size in green sand.

The chief comment which the author desires to make in connection with these tests is that, owing to the extreme sensitiveness of this alloy to changes of casting conditions, none of these results can be accepted as final. It would have been advantageous to have taken the tests in pairs, each pair from a single cast bar, the one test at normal temperature and the other at the desired high temperature.

(To be continued.)

DRAWING OFFICE SYSTEMS AND MANAGEMENT.

By M. Coronel.

(Continued from page 137.)

Drawings and their Execution.

Drawings should be of a standard size, and have the name of the firm, title of drawing, scale, etc., placed in a small space, say, 6 in. × 3 in, in the right-hand bottom corner of the drawing, just inside the border. On the left or right-hand bottom border there should also be left a space, or spaces, divided up to make a record of any subsequent changes, additions, or cancellations made to the drawing as originally issued to the shops.

A Material and Order list should occupy a space on the right-hand border line of the drawing. The material list should specify all material used in the parts shown. The number of each drawing should be placed in large black letters at the left or right-hand bottom corner, so that it is always visible in the drawer by turning up one corner of the drawing. (See Fig. 3.)

In the material list, the number off required, the kind of material, should be given a consecutive item number. This item number should be shown clearly on the drawing at the part it belongs to as a number in circle of about ⅜ in. diameter. Further, the pattern number should be stated behind each item, and a column for remarks left at the end of the list for every item.

The order column should contain the stock order number and general order number, if both are used, and the number of sets off required.

Drawings should be made on thin, white paper, of the Bond variety, in pencil, fully finished and dimensioned, and should be checked by the draughtsman who made it before leaving his hands.

Layouts and general arrangements are often drawn on thicker detail paper, called cartridge paper, as more accurate work can be done on it, and it stands erasures better. The figures should stand out boldly and be easily distinguishable as the process of printing them is apt to diminish their clearness.

When finishing drawings, all surfaces to be machined should bear a distinctive mark along the edge which is required to be machined, and the various classes of finish to be put on such surfaces should be indicated by a standard code of letters, of which the following is a common example:—Finished smooth surfaces, F.S.; finished bright do., F.B.; rough-machined do., R.M.; ground do., G.; spot-faced do., S.F.; file-finished do., F.F. It is also advisable to adopt a code of letters to indicate the material of which the various parts on the drawing have to be made, as indicated in the material list on the right-hand side of the drawing. The following are a few of the most commonly used:—Cast iron, C.I.; mild steel, M.S.; Siemens-Martin steel, S.M.S.; brass, Br.; bronze, Bz.; phosphor-bronze, P.Bz.; gun-metal, G.M.; malleable iron, M.I.; copper, Cu.; nickel, Ni.; nickel steel, Ni.S.; cast steel, C.S.

The Tracing Room.

After the pencil drawing has left the draughtsman, and the design is approved by the chief draughtsman or engineer, it should go to the tracing-room. Tracing nowadays is almost exclusively done by lady tracers, and the old-fashioned male tracer of not very superior standing has almost entirely disappeared from the modern drawing-office.

The drawing should be traced on standard-sized sheets, as stated on page 63; all lettering and figuring being printed according to a standard, to which all tracers should conform. The thickness of lines on full-size drawings should be about 1 millimetre wide, except the dotted and chain-dotted lines, which may be kept thinner. Drawings to a smaller scale, thickness of lines to be in proportion.

When the tracings are finished, and before they leave the tracing-room, the lady head tracer should check the tracings, in order to see that they are exactly similar to the drawings supplied to them as to lines and the correctness of figures and dimensions. It should be pointed out that the draughtsman should spend a good deal more care in the finishing off of his drawings than in the older way, where he had to make his own tracings, and could leave the pencil drawing undimensioned, and small details left off.

It pays the management of engineering firms not

to let experienced draughtsmen do their own tracing, but give this class of work to a less experienced and lower-paid staff, who make a speciality of neatness and printing. The experienced draughtsman can concentrate his energies on calculations, design, and correctness of construction.

The Checker.

After the drawings have been traced they should be returned to the draughtsman in offices where no separate checker is employed, but to the checker where such a man is employed. He, or the draughtsman, should carefully check the dimensions, go over calculations, and compare with the drawings of parts adjoining the part checked. He should specially watch the overlapping and repeating of parts being drawn over again, the adherence to adopted standards, and the standard way the drawing should be finished. He should also make suggestions as to new standards to be adopted, and various other matters simplifying the work in the drawing office or shops. In some drawing offices the checker takes full responsibility for mistakes due to checking or calculating, but it is the author's experience that this is not the best way to run the drawing office most efficiently. The draughtsman who made the drawing and checked it, should still be held responsible for mistakes, as by shifting this responsibility entirely on the checker's shoulders it has a tendency to make even the most experienced draughtsman careless and negligent in his work, which is not conducive to efficiency.

On the other hand, it is most important that errors and mistakes should be kept to a minimum before the drawing leaves the drawing office, as in large works the cost of altering drawings and the hunting up of mistakes through the various shops has been known to cost as much as 10s. per drawing per single error.

Blue Printing.

As mentioned before, all drawings for the shops go there as blue prints of the original cloth tracings, and drawings sent outside are likewise sent as blue prints. Only in certain special cases, such as foundation plans, general arrangements, and other special drawings, which are usually coloured to show different materials and situations, white prints are used.

Blue prints take less time to produce than white prints, about half to one-fifth the time, and are much cheaper. All printing papers should be used fresh, and no stock should be laid in for any duration of time, as the paper deteriorates and becomes useless. They should be kept in air-tight tin cylinders to protect them against damp and light. Both processes are now used with one bath. The blue paper only requires a water bath, the white paper a gallic acid bath.

For the purpose of making new originals, with slight alterations, there is another process of printing, known under the name of sepia prints. They are usually printed on extremely tough thin paper, and the drawing appears as white lines on an extremely dark-brown background. From these, blue prints for shops and sending out can be made, which will have dark-blue lines on a light-blue background,

Printing Machines.

Prints used to be made by exposing the tracing, covering a sheet of blue-print paper, in a frame covered by glass to the rays of the sun, but in modern works the artificial printing by machine, continuous or otherwise, is now almost universally adopted. The principle of all these machines is that the tracing covering the sensitive paper is passed slowly past the rays of one or more electric arc-lights at a speed which can be regulated. In some machines the tracing is stationary, the lamp movable. In some the tracing moves forward, and the lamp moves transversely across it. The baths for developing prints are mostly made from wood, zinc-lined, and a good supply of clean water should be available. The room in which the printing and washing is done should be nearly dark, and the light should fall through red glass windows only. There are various apparatus for drying the prints, ironing them when dry, or nearly so, and for cutting them off straight, as electrically or steam-heated cabinets to hang up drawings, a wringer with steam-heated rollers, and a desk with long guillotine knife, and a receptacle to receive cuttings. The printing is usually done by lads before they go into the drawing office. They should be supervised, however, by a responsible man, who usually attends, at the same time, to the photographing of machinery and catalogue illustration.

(To be continued.)

THE BRITISH INDUSTRIES FAIR.

Although not primarily of interest to the industrial engineer, the British Industries Fair, which opened at the London Dock on February 24th and closed on March 7th, was a most interesting event. The exhibits consisted to a large extent of printing, stationery, fancy goods, and what may be described as allied materials. Industial engineering touches all these trades at many points, and readers of this journal must, therefore, have a certain degree of interest in the success of the Fair. Organised by the Department of Overseas Trade, it promises to be a most useful official institution, that is to say, there is every likelihood of its being instrumental in putting the control of certain markets into British hands. Of course, it rests with our manufacturers and scientists whether this shall be so or not.

The exhibits which were of direct interest to engineers included stands devoted to drawing-office supplies and laboratory equipment, together with engineering requisites like gauge glasses, etc. In connection with the last-named, Messrs. John Moncrieff Ltd., of Perth, had a fine display of their specialities. As our readers know, Messrs. Moncrieff are makers of quite a wide range of gauge glasses such as the "Perth," a glass that gives great satisfaction on boilers working at ordinary pressures; the "Unific," a special high-grade glass for the highest steam pressures, and the utmost variation of temperature; the "Super," a recent prduction on the lines of the "Unific," but of harder glass. They also had on view an interesting collection of their sight-feed lubricator glasses and reflex gauge glasses, of the Klinger type. Another of this firm's special productions is their miners' lamp glass. These

glasses are made from Professor Jackson's resistant formula, as issued by the Glass Research Committee.

Messrs. A. C. Cossor and Son, Accoson Works, Vale Road, Finsbury Park, London, exhibited all kinds of thermometers for engineering purposes, as well as chemical and laboratory outfits. Gauges recording and otherwise were also in their collection. Hygrometers for stores, drying sheds, etc., were shown by Messrs. Dring and Fage, of 56, Stamford Street, London, S.E., who had in addition their hydrometers, specific gravity instruments, and numerous other articles of interest to the chemist and research specialist. Messrs. Howard, Rawson and Co. Ltd., 21b, Pond Place, Chelsea, London, S.W. 3, who are makers of graduated glass apparatus, glass stop-cocks, chemical apparatus, and scientific instruments, had a stand well worth attention, as had Messrs. Negretti and Zambra, of 38, Holborn Viaduct, London. The exhibits of the latter were of the customary variety, including their well-known meteorological apparatus. The Scientific Supplies Co. Ltd., 52, Hatton Garden, London, displayed an interesting collection of acid-oil flasks, condensers, gas analysis bulbs, mercury gauges, steam, factory, and other thermometers, and, in fact, scientific glassware of all kinds. The makers of Thermos flasks, Messrs. Thermos Ltd., 2/4, Finsbury Street, London, E.C. 2, had, besides their original Thermos flasks, jugs and food jars, a display of aeronautical flasks, liquid air vessels, vacuum gas bulbs, and laboratory glass. The last stand in this section to be noted was that of Wood Brothers Glass Co. Ltd., Borough Flint Glass Works, Barnsley, who are makers of scientific and laboratory glassware. This firm make glassware in two qualities; one, a soft soda glass, and the other a high resistant glass for analytical and research work. They had a wide and varied display of their products.

The Berkefeld Filter Co., Sardinia House, Kingsway, London, exhibited different patterns of the "Berkefeld" filter which were previously made by the German Company. This firm is now entirely British-owned. The filtering cylinders are made of Kuselgahr, and the quality is said to be equal, if not superior, to the cylinders made by the late company.

In drawing office materials, the British Drawing Ink and Adhesives Manufacturing Co., 31, Great Ormond Street, London, W.C., made a good show. Besides specialising in drawing inks for draughtsmen, engineers, etc., they prepare a white gum for office and general use, as well as albumen colours for tinting photographs, lantern slides, etc. Messrs. F. Chambers Co. Ltd., Garden Pencil Works, Stapleford, Notts, showed a large assortment of pencils for engineers, draughtsmen, and others, as did E. Wolff and Son Ltd., of 82, St. Thomas Street, London, who are makers of the well-known pencils, Royal Sovereign, Bank of England, and many others. Others in this section were Messrs. Winsor and Newton Ltd., of Rathbone Place, Oxford Street, London, and the Students' Colour Co.

Most of the firms who were spoken to with regard to the export trade appear to be quite sanguine as to the possibilities of doing something really substantial, but they are unable to expand as quickly as they would like owing to the difficulty of securing the very special labour which they need. Take the manufacture of gauge and other glass: men are not being got back from the army as rapidly as the makers would like, though, alas, there are many who will return no more. The immediate future of the trade in the sections referred to, therefore, to a great extent, entirely, one might say, depends upon the rapidity with which labour, both skilled and unskilled, is forthcoming to cope with the works' orders that are on the books. This is a factor that the Board of Trade might do what it can to deal with, as it is obvious that the country's trade cannot be speeded up unless the organisers of trade and industry have a large army of men at their disposal. Even trade wars must be waged on the basis of numbers of highly-trained and efficient men, though in the ranks of industry, as in the subsidiary army organisations, women are serving splendidly and on an increasing scale.

GOVERNORS AND GOVERNING MECHANISM.

By A. Houlson.

(Continued from page 187.)

Having described the details of this governor, we will take up an actual case for consideration.

The governor was fitted to a cross-compound vertical engine of the enclosed type. The high-pressure cylinder was 23 in. diameter by 18 in. stroke, the initial pressure in the cylinder being 180 lbs. per square inch. The mean speed of the engine was 250 revs. per min. The diameter of the high-pressure piston valve was $11\frac{1}{2}$ in., having a maximum travel of 6 in., decreasing to a minimum travel of $2\frac{1}{4}$ in. Lead at largest travel = 7/16 in. top, 17/32 in. bottom. Lead at smallest travel = zero.

Top steam lap = $1\frac{1}{4}$ in.; bottom steam lap = 1 5/32 in. The mean cut-off varied from 0 per cent to 65 per cent.

The least travel given to the outer eccentric by the governor must be such that the half travel of the valve shall be less than the bottom steam lap. (The bottom lap is always less than the top lap.) In the present example the bottom lap is 1 5/32 in., so that the least travel of the valve may be $2\frac{1}{4}$ in., and the distance from the centre of the shaft to the centre of the outer eccentric will be $1\frac{1}{8}$ in. in this position. This will be sufficient to prevent any passage of steam. With a mean cut-off of 65 per cent we find the greatest valve travel to be 6 in., therefore, the distance from the centre of the shaft to the centre of the outer eccentric must be 3 in. in this position. The eccentric follows the crank as shown in Fig. 43, the piston valve taking steam at the inside edges.

To obtain the movements of the link F in Fig. 44 the arc BD is struck from the centre E of the inner eccentric, and the distance AB equals the distance CD. This gives us the two extreme positions, B and D of the pin which connects the link to the outer eccentric. The length of the link is then taken in the dividers and the length and travel of the lever A determined as shown.

The size of the spring will next be determined.

The weight and the centre of gravity of the weight bar is calculated as accurately as possible by the method of moments as explained in previous examples. After the bar has been cast and machined it is carefully weighed and found to be 350 lbs. weight. It is then suspended loosely on a mandrel at P, and a plumb-line is dropped as shown in Fig. 47. The distance y is now measured and found to be $14\frac{1}{4}$ in. A quantity of lead is placed in the pocket D until the bar takes up a horizontal position. The lead is then removed, weighed, and found to be $21\frac{1}{2}$ lbs.

Then, taking moments about P_1 (see Fig. 43), 350 lbs. × 1.41 in. = $21\frac{1}{2}$ lbs. × 23 in.

The centre of gravity lies, then, on a vertical line distant 1.41 in. from the centre line of the pivot P_1. The intersection of this vertical line with the plumb-line gives the centre of gravity at mid position. Having found the centre of gravity we may determine the centrifugal force at the "in," "mid," and "out" positions of the weight bar from the formula $.00034\ W R N^2$, where W = weight of both bars = 700 lbs.; R = radial distance (in feet) from the centre of the

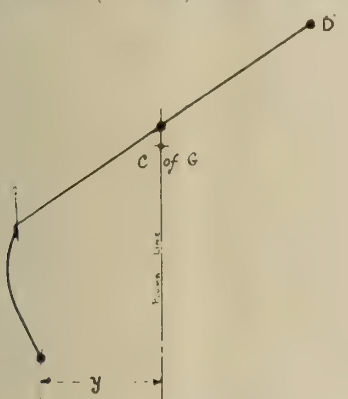

FIG. 47.—GOVERNORS.

shaft to the centre of gravity = 1.06 at "in" position; 1.094 at "mid" position; 1.135 at "out" position. N = number of revolutions per minute = $246\frac{1}{4}$ at "in" position; 250 at "mid" position; and $253\frac{3}{4}$ at "out" position.

From this data, we have:—
Centrifugal force at "in" position = 15,295 lbs.; centrifugal force at "mid" position = 16,273 lbs.; centrifugal force at "out" position = 17,382 lbs. It is at the "mid" position only that the moment of the centrifugal force is exactly equal to the moment of the spring load; but the deviation from equilibrium in the other positions is so small that a near approximation may be made to the flexibility of the spring.

The equations of moments for the three positions are:—

"In" positions:

$$15295 \times \cdot 875 = \text{tension in spring } (12\tfrac{3}{8} - 6\tfrac{3}{4}).$$

"Mid" positions:

$$16273 \times 1\cdot 41 = \text{tension in spring } (13\tfrac{5}{8} - 7\tfrac{1}{2}).$$

"Out" positions:

$$17382 \times 1\cdot 875 = \text{tension in spring } (14 - 7\tfrac{5}{8}).$$

The initial tension of spring

$$= \frac{15295 \times \cdot 875}{5\cdot 625} = 2379 \text{ lbs. approximately.}$$

The final tension of spring

$$= \frac{17382 \times 1\cdot 875}{6\cdot 375} = 5112 \text{ lbs. approximately.}$$

The difference of tensions = 5112 − 2379 = 2733 lbs.

The next step is to determine the flexibility of the spring, and for this we must find its travel.

To obtain the travel, first draw the weight bars at "out" position and find the centres of the knife edges. Then draw the bars at "in" position and find the corresponding knife edge centres. The difference between the centres is the travel of the spring.

In this example we have:—"Out" centres, 2 ft. $7\frac{1}{8}$ in.; "in" centres, 2 ft. 3 13/16 in.; and travel of spring, 3 5/16 in. Therefore, the flexibility of the spring

$$= \frac{2733}{3\cdot 3125} = 825 \text{ lbs. per inch.}$$

At "mid" position the centres of the knife edges are 2 ft. 5 5/16 in.; that is, the spring has been extended $1\frac{1}{2}$ in. from the "in" position; also the tension at "mid" position

$$= \frac{16273 \times 1\cdot 41}{6\cdot 125} = 3746 \text{ lbs.}$$

The extension from rest at "mid" position

$$= \frac{3746}{825} = 4\cdot 54 \text{ in.}$$

The initial extension will be 4.54 − 1.5 = 3.04 in., and the final extension = 4.54 + 1.8125 = 6.3525 in.

The spring was made to the following particulars: Outside diameter of coils, 10 in.; diameter of wire, 1 5/16 in.; number of coils, 8; Free length, $10\frac{3}{4}$ centres + $1\frac{1}{2}$ coil. The controlling force of this governor is = .02 × 16,273 × $1\frac{1}{4}$ ÷ $1\frac{7}{8}$ = 217 lbs. or 18.85 lbs. per inch diameter valve.

(To be continued.)

CHIMNEY STACKS.

By JAMES CLAUGHTON.

(Continued from page 175.)

THE following tests are reproduced by permission of the various plant manufacturers, whose names appear in the text. From these tests the reader will be able to draw his own conclusions, and compare them with the deductions given herein by the author.

Report of boiler test on two Lancashire boilers, 8 ft. by 30 ft. and 7 ft. 6 in. by 30 ft. respectively carried out at one of the branches of a large textile combine:—

System of firing: By hand.
Duration of test: $6\frac{3}{4}$ hours.
Heating surface of each boiler: 998 and 945 square feet.
Grate surface of each boiler: 38 and 36 square feet.
Smoke produced during test: Continuous black.

Average temperature of feed water entering economiser: 69 deg. Fah.
Average temperature of feed water entering boiler: 230 deg. Fah.
Average steam pressure by gauge: 40 lb. per square inch.
Class of coal: Scotch dross.
Calorific value of coal per pound, as fired, 12,211 B.Th.U.
Total weight of coal burnt: 20,720 lb.
Coal burnt per boiler per hour: 1,554 lb.
Coal burn per square foot of grate surface per hour: 42 lb.
Total quantity of water evaporated: 133,280 lb.
Water evaporated per boiler per hour: 9,996 lb.
Water evaporated per hour, as from and at 212 deg. Fah.: 11,718 lb.
Water evaporated, as from and at 212 deg. Fah. per square foot of boiler heating surface per hour: 12.1 lb.
Water evaporated per pound of coal, as from and at 212 deg. Fah.: 7.54 lb.
Total thermal efficiency obtained: 59.64 per cent.

Report on Boiler Test made at a Manchester Colliery.

System of firing: Hand.
Duration of test: 7 hours.
Number of boilers: One.
Type of boiler: Lancashire.
Size of boiler: 8 ft. 6 in. by 30 ft.
Temperature of feed-water, entering boiler: 223 deg. Fah.
Steam pressure by gauge: 82.3 lb. per square inch.
Factor of equivalent evaporation, as from and at 212 deg. Fah. (boiler only): 1.0245.
Class of coal: Burgy.
Calorific value of coal per pound, as fired: 11,657 B.Th.U.
Total weight of coal burnt: 9,184 lb.
Coal burnt per boiler per hour: 1,312 lb.
Coal burnt per square foot of grate surface per hour: 32.8 lb.
Total quantity of water evaporated: 55,000 lb.
Water evaporated per boiler per hour: 7,857 lb.
Water evaporated per pound of coal: 6 lb.
Total equivalent evaporation: 56,350 lb.
Equivalent evaporation per boiler per hour: 8,050 lb.
Equivalent evaporation per square foot of boiler heating surface per hour: 7.4 lb.
Equivalent evaporation per pound of coal: 6.14 lb.
Total thermal efficiency obtained: 50.83 per cent.

The real point at issue on any system of firing is to ensure proper combustion of the fuel. This can only be accomplished by allowing the correct proportion of air to be admitted to the furnace. The correct proportion to meet the requirements in any particular case depends entirely on the chemical analysis of the fuel used. Further, the amount of air admitted must be under perfect control.

Providing a suitable means of ensuring the foregoing ideal can be made possible, it makes no practical difference worth speaking about whether this is accomplished entirely by mechanical devices or otherwise. It is the uncertainty that is always apparent when ordinary hand-firing is done that prevents the ideal from being actually carried out in practice, chiefly because there is no adequate system of controlling the air supply on ordinary boiler furnaces.

To form a basis from which to prove the above assertion, the following test is reproduced. This test was carried out at the Manchester colliery previously stated, and the boiler in question was fitted with a "Bennis" Patent Compressed-air Bar, the boiler being hand-fired. The practical result was a reduction in fuel cost of 15 per cent, whereas the extra water evaporated, as from and at 212 deg. Fah. per boiler per hour was increased by 32 per cent, and the equivalent evaporation per pound of coal was increased by 17.6 per cent:—

Report on Boiler Test made at a Manchester Colliery.

System of firing: By hand, with compressed-air furnace fitted.
Duration of test: 7 hours.
Number of boilers: One.
Type of boiler: Lancashire.
Size of boiler: 8 ft. 6 in. by 30ft.
Temperature of feed-water, entering boiler: 234 deg. Fah.
Steam pressure by gauge: 99.3 lb. per square inch.
Factor of equivalent evaporation, as from and at 212 deg. Fah.: 1.0166.
Class of coal: Burgy.
Calorific value of coal per pound, as fired: 11.604 B.Th.U.
Total weight of coal burnt: 10,304 lb.
Coal burnt per boiler per hour: 1,472 lb.
Coal burnt per square foot of grate surface per hour: 36.8 lb.
Total quantity of water evaporated: 73,200 lb.
Water evaporated per boiler per hour: 10,457 lb.
Water evaporated per pound of coal: 7·1 lb.
Total equivalent evaporation: 74,413 lb.
Equivalent evaporation per boiler per hour: 10,630 lb.
Equivalent evaporation per square foot of boiler heating surface per hour: 9.8 lb.
Equivalent evaporation per pound of coal: 7.22 lb.
Total thermal efficiency obtained: 60.1 per cent.

(To be continued.)

ELECTRODE MANUFACTURE.

Following the outbreak of war and the increased demand for special steels, which resulted in large additions to the number of electric furnaces in operation, the shortage of electrodes for these furnaces speedily became acute, the more so as Great Britain was, to a large extent, dependent upon foreign supplies of this material.

As is well known, electrodes for the electric steel furnace are of graphite or amorphous carbon, the former having the higher current conductivity, and being considerably more expensive, though the price

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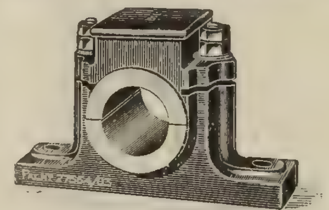

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Weights of Lengths of Rolled Steel Sections.

Beam 3 in. × $1\frac{1}{2}$ in. × $4\frac{1}{2}$ lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	Ft.
0	0 0 0	0 1 17·0	0 3 6·0	1 0 23·0	1 2 12·0	2 0 1·0	2 1 18·0	2 3 7·0	3 0 24·0	3 2 13·0	0
1	0 0 4·5	0 1 21·5	0 3 10·5	1 0 27·5	1 2 16·5	2 0 5·5	2 1 22·5	2 3 11·5	3 1 0·5	3 2 17·5	1
2	0 0 9·0	0 1 26·0	0 3 15·0	1 1 4·0	1 2 21·0	2 0 10·0	2 1 27·0	2 3 16·0	3 1 5·0	3 2 22·0	2
3	0 0 13·5	0 2 2·5	0 3 19·5	1 1 8·5	1 2 25·5	2 0 14·5	2 2 3·5	2 3 20·5	3 1 9·5	3 2 26·5	3
4	0 0 18·0	0 2 7·0	0 3 24·0	1 1 13·0	1 3 2·0	2 0 19·0	2 2 8·0	2 3 25·0	3 1 14·0	3 3 3·0	4
5	0 0 22·5	0 2 11·5	1 0 0·5	1 1 17·5	1 3 6·5	2 0 23·5	2 2 12·5	3 0 1·5	3 1 18·5	3 3 7·5	5
6	0 0 27·0	0 2 16·0	1 0 5·0	1 1 22·0	1 3 11·0	2 1 0·0	2 2 17·0	3 0 6·0	3 1 23·0	3 3 12·0	6
7	0 1 3·5	0 2 20·5	1 0 9·5	1 1 26·5	1 3 15·5	2 1 4·5	2 2 21·5	3 0 10·5	3 1 27·5	3 3 16·5	7
8	0 1 8·0	0 2 25·0	1 0 14·0	1 2 3·0	1 3 20·0	2 1 9·0	2 2 26·0	3 0 15·0	3 2 4·0	3 3 21·0	8
9	0 1 12·5	0 3 1·5	1 0 18·5	1 2 7·5	1 3 24·5	2 1 13·5	2 3 2·5	3 0 19·5	3 2 8·5	3 3 25·5	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight
	0 ·375	0 ·75	0 1·125	0 1·5	0 1·875	0 2·25	0 2·625	0 3	0 3·375	0 3·75	0 4·125	0 4·5	

Weights of Lengths of Rolled Steel Sections.

Beam 3 in. × $1\frac{1}{2}$ in. × $4\frac{1}{2}$ lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 0 2	8 0 4	12 0 6	16 0 8	1 0 0 10	1 4 0 12	1 8 0 14	1 12 0 16	1 16 0 18	0
10	0 1 17	4 1 19	8 1 21	12 1 23	16 1 25	1 0 1 27	1 4 2 1	1 8 2 3	1 12 2 5	1 16 2 7	10
20	0 3 6	4 3 8	8 3 10	12 3 12	16 3 14	1 0 3 16	1 4 3 18	1 8 3 20	1 12 3 22	1 16 3 24	20
30	1 0 23	5 0 25	9 0 27	13 1 1	17 1 3	1 1 1 5	1 5 1 7	1 9 1 9	1 13 1 11	1 17 1 13	30
40	1 2 12	5 2 14	9 2 16	13 2 18	17 2 20	1 1 2 22	1 5 2 24	1 9 2 26	1 13 3 0	1 17 3 2	40
50	2 0 1	6 0 3	10 0 5	14 0 7	18 0 9	1 2 0 11	1 6 0 13	1 10 0 15	1 14 0 17	1 18 0 19	50
60	2 1 18	6 1 20	10 1 22	14 1 24	18 1 26	1 2 2 0	1 6 2 2	1 10 2 4	1 14 2 6	1 18 2 8	60
70	2 3 7	6 3 9	10 3 11	14 3 13	18 3 15	1 2 3 17	1 6 3 19	1 10 3 21	1 14 3 23	1 18 3 25	70
80	3 0 24	7 0 26	11 1 0	15 1 2	19 1 4	1 3 1 6	1 7 1 8	1 11 1 10	1 15 1 12	1 19 1 14	80
90	3 2 13	7 2 15	11 2 17	15 2 19	19 2 21	1 3 2 23	1 7 2 25	1 11 2 27	1 15 3 1	1 19 3 3	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight
	2 0 0 20	4 0 1 12	6 0 2 4	8 0 2 24	10 0 3 16	12 1 0 8	14 1 1 0	16 1 1 20	18 1 2 12	20 1 3 4	

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Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 12 in. × 107 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	9 2 6	0 19 0 12	1 8 2 18	1 18 0 24	2 7 3 2	2 17 1 8	3 6 3 14	3 16 1 20	4 5 3 26	0
1	0 3 23	10 2 1	1 0 0 7	1 9 2 13	1 19 0 19	2 8 2 25	2 18 1 3	3 7 3 9	3 17 1 15	4 6 3 21	1
2	1 3 18	11 1 24	1 1 0 2	1 10 2 8	2 0 0 14	2 9 2 20	2 19 0 26	3 8 3 4	3 18 1 10	4 7 3 16	2
3	2 3 13	12 1 19	1 1 3 25	1 11 2 3	2 1 0 9	2 10 2 15	3 0 0 21	3 9 2 27	3 19 1 5	4 8 3 11	3
4	3 3 8	13 1 14	1 2 3 20	1 12 1 26	2 2 0 4	2 11 2 10	3 1 0 16	3 10 2 22	4 0 1 0	4 9 3 6	4
5	4 3 3	14 1 9	1 3 3 15	1 13 1 21	2 2 3 27	2 12 2 5	3 2 0 11	3 11 2 17	4 1 0 23	4 10 3 1	5
6	5 2 26	15 1 4	1 4 3 10	1 14 1 16	2 3 3 22	2 13 2 0	3 3 0 6	3 12 2 12	4 2 0 18	4 11 2 24	6
7	6 2 21	16 0 27	1 5 3 5	1 15 1 11	2 4 3 17	2 14 1 23	3 4 0 1	3 13 2 7	4 3 0 13	4 12 2 19	7
8	7 2 16	17 0 22	1 6 3 0	1 16 1 6	2 5 3 12	2 15 1 18	3 4 3 24	3 14 2 2	4 4 0 8	4 13 2 14	8
9	8 2 11	18 0 17	1 7 2 23	1 17 1 1	2 6 3 7	2 16 1 13	3 5 3 19	3 15 1 25	4 5 0 3	4 14 2 9	9

Weight of Beam, advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q lbs.	q. lbs.	Weight.
	8·917	17·83	26·75	1 7·66	1 16·58	1 25·5	2 6·41	2 15·31	2 29·25	3 5·17	3 14·08	3 23	

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 12 in. × 107 lbs. per foot.

[ALL RIGHTS RESERVED.]

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 15 2 4	9 11 0 8	14 6 2 12	19 2 0 16	23 17 2 20	28 13 0 24	33 8 3 0	38 4 1 4	42 19 3 8	0
10	0 9 2 6	5 5 0 10	10 0 2 14	14 16 0 18	19 11 2 22	24 7 0 26	29 2 3 2	33 18 1 6	38 13 3 10	43 9 1 14	10
20	0 19 0 12	5 14 2 16	10 10 0 20	15 5 2 24	20 1 1 0	24 16 3 4	29 12 1 8	34 7 3 12	39 3 1 16	43 18 3 20	20
30	1 8 2 18	6 4 0 22	10 19 2 26	15 15 1 2	20 10 3 6	25 6 1 10	30 1 3 14	34 17 1 18	39 12 3 22	44 8 1 26	30
40	1 18 0 24	6 13 3 0	11 9 1 4	16 4 3 8	21 0 1 12	25 15 3 16	30 11 1 20	35 6 3 24	40 2 2 0	44 18 0 4	40
50	2 7 3 2	7 3 1 6	11 18 3 10	16 14 1 14	21 9 3 15	26 5 1 22	31 0 3 26	35 16 2 2	40 12 0 6	45 7 2 10	50
60	2 17 1 8	7 12 3 12	12 8 1 16	17 3 3 20	21 19 1 24	26 15 0 0	31 10 2 4	36 6 0 8	41 1 2 12	45 17 0 16	60
70	3 6 3 14	8 2 1 18	12 17 3 22	17 13 1 26	22 9 0 2	27 4 2 6	32 0 0 10	36 15 2 14	41 11 0 8	46 6 2 22	70
80	3 16 1 20	8 11 3 24	13 7 2 0	18 3 0 4	22 18 2 8	27 14 0 12	32 9 2 16	37 5 0 20	42 0 2 24	46 16 1 0	80
90	4 5 3 26	9 1 2 2	13 17 0 6	18 12 2 10	23 8 0 14	28 3 2 18	32 19 0 22	37 14 2 26	42 10 1 2	47 5 3 6	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight
	47 15 1 12	95 10 2 24	143 6 0 8	191 1 1 20	238 16 3 4	286 12 0 16	334 7 2 0	382 2 3 12	429 18 0 24	477 13 2 28	

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ENGINEERING APPOINTMENTS OPEN.

PERSONAL NOTES.

Messrs. Hale, Louth, and Co. Ltd., electrical and mechanical engineers, late of Greengate, Salford, have now removed to much larger premises at Hewitt Street, Deansgate, Knott Mill, Manchester. The title of the company has been changed to Hale, Pearn and Co. Ltd.

The Sloan Electrical Co. Ltd., of 12, Golden Lane, London, E.C.1., opened a new branch and warehouse at Edinburgh on the 1st inst. This branch will be in charge of **Mr. James Sloan,** who was for many years with Messrs. Mackenzie and Moncur Ltd., of Balcarres Street, Edinburgh. The address of the new premises is 79, 81, and 85, Hanover Street, Edinburgh.

Messrs. Tittley, Son and Brickley Ltd., power transmission specialists, Alton Works, Smethwick, call attention to the fact that their plant, which was increased to meet demands for war material, is being retained at full strength for after-war requirements.

The Rodley Gas Engine Works, Rodley, Leeds, have removed into more commodious premises, and are now in a position to accept orders for the "Rodley" gas engines, and also electrical and general engineering work. They have also installed a special plant for small gear cutting.

Mr. H. R. Howard has retired from partnership in Messrs. Buckman and Howard, motor and general engineers, Canal Street, Nottingham, and his interest has been acquired by **Mr. H. Gauntley Price,** of West Bridgford, late of Messrs. Cammell Laird and Co. Ltd. The new firm will be carried on under the style of Messrs. Buckman and Price.

Mr. L. C. Harvey has commenced business at 25, Victoria Street, S.W., as an advisory engineer in connection with furnace design, fuel economy, etc.

At the annual meeting of members of the Institution of Mechanical Engineers, **Mr. Edward Hopkinson, D.Sc., M.P.** for the Clayton Division of Manchester, was elected president of the Institution. This is the highest honour which those practising the profession of mechanical engineering in the British Empire can bestow. The first and second presidents of the Institution were George and Robert Stephenson, and they were succeeded by Sir William Fairbairn, Sir Joseph Whitworth, and Lord Armstrong. Among later presidents have been Sir Frederick Bramwell, Sir William White, Sir Frederick Donaldson, Sir Alexander Kennedy, and Sir John Aspinall.

Mr. C. M. Ferguson, superheater specialist, has rejoined the staff of James Gordon and Co., of Queen's House, Kingsway, London, W.C.2, in charge of their steam-power department.

Regarding the establishment of the Midland Electric Power Installation Company in Birmingham, by **Mr. Henry Joseph, A.M.I.E.E.,** it is announced that premises have been secured at Old Mill Street, Wolverhampton. These premises are equipped for motor and other electrical repairs. There will be a staff both in Birmingham and Wolverhampton. For the present all business will be transacted from the Wolverhampton address.

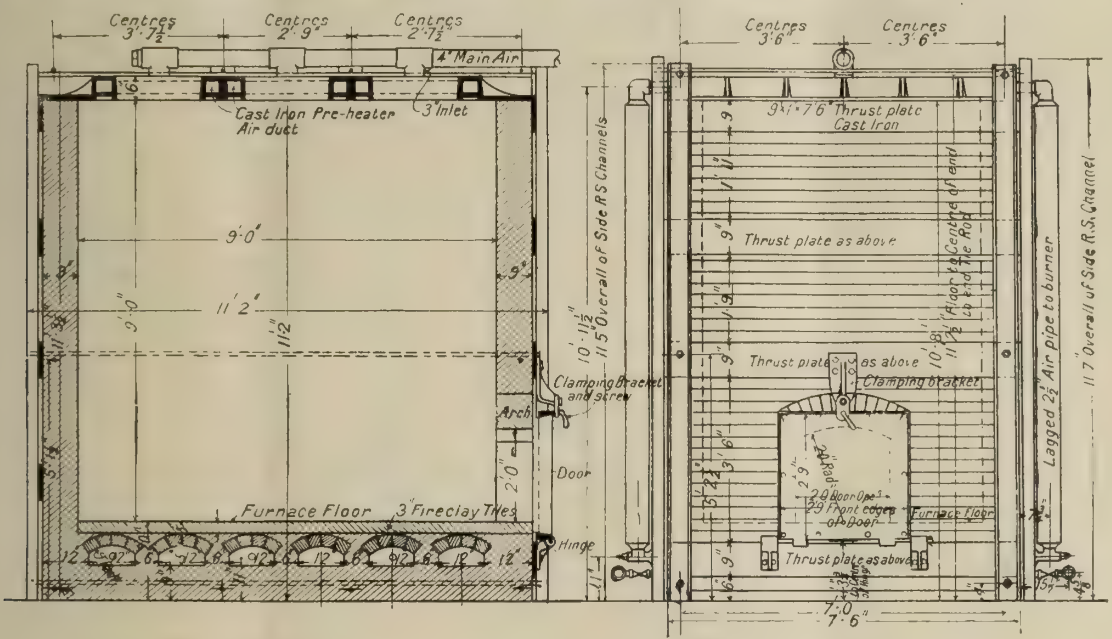
The Newall Engineering Co., which, during the latter part of the war was taken over by the Ministry of Munitions, and operated as a national gauge factory, has now been reverted to its former proprietors, Messrs. Peter Hooker Ltd. Accordingly, it is understood that the company intends to reorganise and develop its pre-war business, and to undertake the manufacture of additional specialities. The Newall Engineering Co. has appointed **Captain R. J. Bray,** Director of the Machine Tool Section, Aircraft Production Department, as general manager.

For the more efficient carrying on of their business, the Electric Construction Co. Ltd. opened a branch office at 166, St. Vincent Street, Glasgow, on the 1st inst. Their telegraphic address will be "Winningly, Glasgow," and telephone number "Central 1044." **Mr. W. L. Winning,** who has been connected with the Glasgow office of the British Westinghouse Co. Ltd. for twelve years, and who is well known in the West of Scotland, has been appointed sole representative.

of even the cheaper amorphous carbon electrodes is now well over £40 per ton. The electrode consumption of modern steel furnaces is usually given as about 10 lbs. per ton of steel, but it may be assumed that the average consumption, including breakages, is well over double this figure, so that it will be seen this is an important factor for the steel maker. The consumption, when melting brass (for which purpose the electric furnace has been tentatively used in the United States) is, as might be expected, considerably lower, and with a modern furnace is only abut $1\frac{1}{2}$ lbs. per ton of red brass melted, apart from accidental breakages.

Amorphous carbon electrodes have for a considerable time past been obtainable in Great Britain, though their manufacture has presented some few difficulties; and some little time ago the Davis Furnace Co., of Luton, Beds., were commissioned to design a type of oven furnace which would overcome the trouble which had been experienced in satisfactorily annealing this material. The work calls for extremely uniform temperatures throughout the heating chamber, varying from 450 to 600 deg. Cen., which have to be maintained for long periods with great accuracy, and it is only possible to meet these requirements by the employment of gaseous fuel. It is perhaps needless to add that the strong affinity of carbon for oxygen makes the provision of a perfect reducing atmosphere in the heating chamber a *sine qua non.* The best results are obtainable if the electrodes are annealed in a vertical position, so it will be seen that a furnace capable of taking a charge of, say, 20 in. diameter carbons requires to be of very large dimensions.

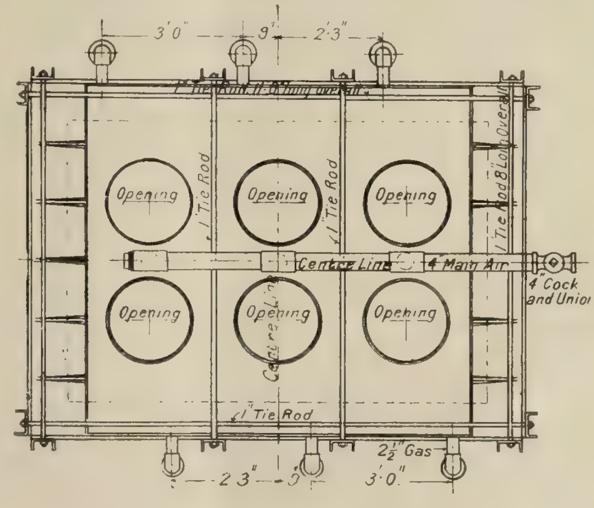
The particular furnace illustrated is installed in a large steel works in the Midlands, whose output of electric steel exceeds 30,000 tons per annum. It will be seen from Figs. 1 and 2 that the heating chamber measures 9 ft. wide by 6 ft. back to front by 9 ft. high, and is designed to accommodate six electrodes at a time, of sizes up to 22 in. diameter. The furnace is constructed of a special quality refractory material, with walls 9 in. thick, bound by means of channel irons and tie-rods. A supplementary access door 2 ft. by 2 ft. is fitted at one end for the purpose of removing electrodes which may be accidentally broken during insertion, and it also provides a convenient means of effecting slight repairs. This door is of the hinged drop-down type, and is fastened by means of a clamp screw. The top of the furnace, or cover-plate, is in two parts, of box section, and in addition to providing for the insertion and support of the electrodes it serves as a preheater for the air supply taken by the burners.



Section.

End Elevation.

ELECTRODE MANUFACTURE.—FIG. 1.

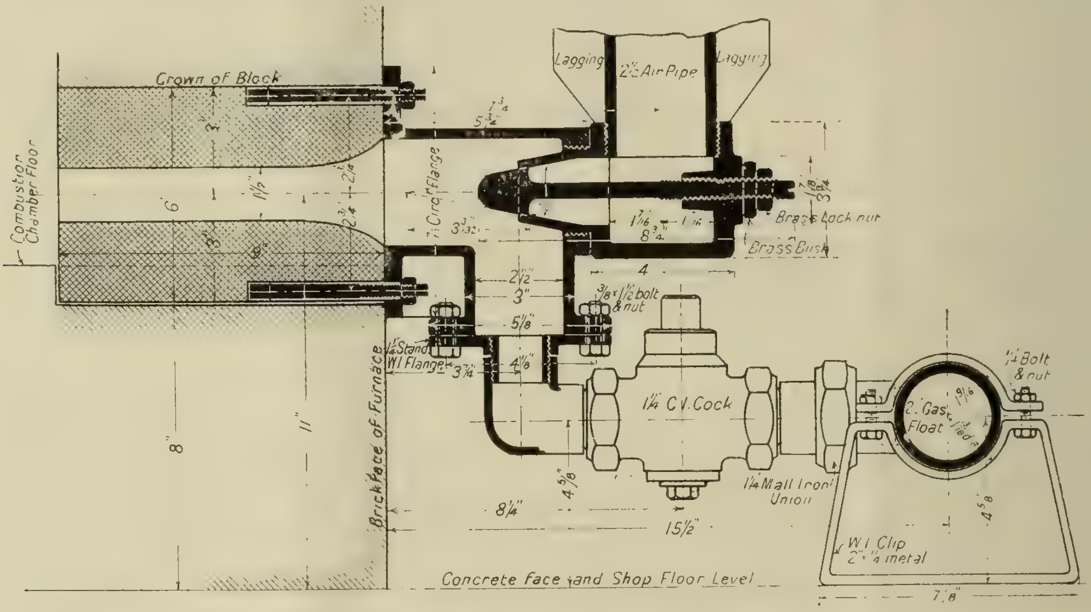


Plan on Top.

ELECTRODE MANUFACTURE.—FIG. 2.

The burners are of the makers' so-called fan-air type, for consuming gas at town pressure under a slight supplementary air pressure of about 6 in.

water column. The construction of these burners is shown in Fig. 3, from which it will be seen that the nozzle (which in every type of burner is the part which requires most frequent renewal) is formed of a refractory block which can be easily and cheaply replaced. Each of the burners, numbering six in all, has a $1\frac{1}{4}$-in. gas service and a $2\frac{1}{2}$-in. air supply, separate main controls being provided for both gas and air, while the permanent air rate of the burner can be adjusted by manipulation of the regulating plug. Three burners are placed on each side of the furnace, firing into combustion chambers or tunnels each 12 in. wide by 5 in. high, placed underneath the floor of the heating chamber, of such size and shape as to ensure complete combustion of the gas



Electrode Manufacture.—Fig. 3.

and air therein. The burners are arranged to fire alternately from each side to ensure even distribution of heat.

The air supply for the burners, at a pressure in the neighbourhood of 6-in. water gauge, furnished by a standard open type of fan, is forced through the 4-in. main air-supply pipe on top of the furnace through various 3-in. inlet tees into the cast-iron preheater chambers in the cover plate, thence to the burners by separate $2\frac{1}{2}$-in. legged air pipes.

If necessary, this type of furnace can be arranged with the heating chamber divided by a central partition wall, which enables two kinds of electrodes requiring different annealing temperatures to be treated at the same time.

THE REINSTATEMENT OF SOLDIERS AND SAILORS IN CIVIL LIFE.

No more urgent task follows upon the demobilisation of the Forces than the reinstatement in civil life of the soldiers and sailors. The number of men to be dealt with in this country alone makes the labour gigantic; but the machinery exists for performing it, and it only remains for intending employers and employees to avail themselves of their opportunity. The Employment Exchanges, assisted by the Local Advisory Committees, which represent equally the interests of both parties in every neighbourhood, have the organisation ready for use. The staffs of the Exchanges have been considerably strengthened in order to meet the extra strain thrown upon them. It is not generally known that branches have been set up to deal with discharged men only, and in a great number of cases special sections for disabled men having been established. As far as possible, the work in these new additions to the Exchange system is carried on by men in the same position as those whom they are helping back into civil employment. Discharged men, with no small proportion of disabled among them, superintend the placing of discharged and disabled men. It has been found that the loss of an arm, of a leg, of two legs, and even of eyesight is no insurmountable obstacle to the performance of efficient work, given employers who will employ the men, and the Exchanges which make use of such men are patent examples of the fact that war, even when it has dealt serious bodily injuries, does unfit the fighter for successful life as a civilian.

ENGINEERING LAY-OUT ARRANGEMENTS AND TENDER DRAWINGS.

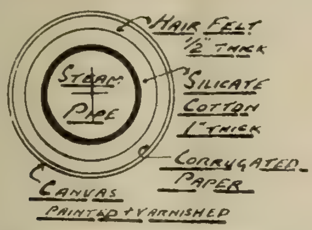
By Douglas Wilson, A.M.I.Mech.E.

(*Continued from page 177.*)

Fig. 53 shows a steam pipe covered with this material, the thickness being 1 in. This is suitable for pipes up to 2-in. bore. For pipes up to 5-in. bore, $1\frac{1}{2}$ in. thick, and larger diameters 2 in. thick. Outside this silicate cotton is a layer of hair felt $\frac{1}{2}$ in. thick, and, finally, corrugated paper bound round with painted and varnished canvas. This forms a high-class engine-room pipe covering, and is much in vogue in important power plants. The flanges in a steam main must not be forgotten, as if they are left uncovered they will radiate considerable heat.

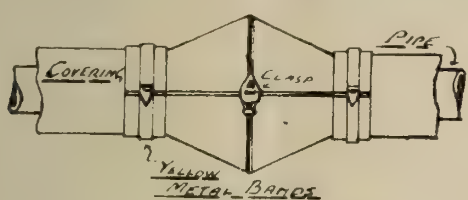
Various forms are adopted and are generally in the form of hinged metal boxes lined with the conducting material used. Fig. 54 illustrates a very neat case designed by Messrs. Cameron Hastie and Co. Figs. 55 and 56 show a cheaper silicate cotton covering, the material being sewn to tarred felt, and covered with wire netting. This is very suitable for underground pipes.

Magnesia covering is largely used both on land and



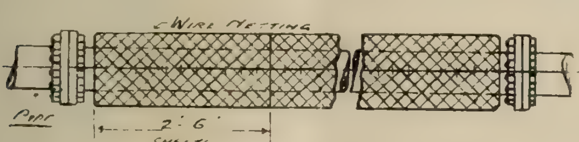
ENGINEERING LAY-OUT.—FIG. 53.

sea, it being non-combustible, as well as being an excellent non-conductor. For high pressures the composition should contain 85 per cent of hydrated carbonate of magnesia and 15 per cent of asbestos fibre. Pipes covered with magnesia are done either by the sectional covering, supplied and moulded to suit any size of pipe, and covered with canvas and secured by light metal bands; or, alternatively, coated over with magnesia plastic covering by means of a



ENGINEERING LAY-OUT.—FIG. 54.

trowel. The magnesia for this last method is generally sent out dry in bags holding about ½ cwt., and must be mixed with enough water to form a soft mortar. The pipes to be covered should be warm, not at their greatest heat, and should be well cleaned before the mixture is applied. The first layer should be about ⅜ in. thick, and allowed to dry before applying the others. The first layers could be applied with a brush, and the last with a trowel, using a straight-edge. When the surface is quite smooth and dry,

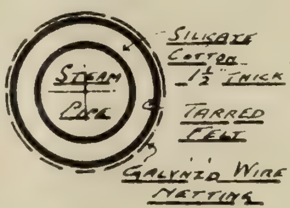


ENGINEERING LAY-OUT.—FIG. 55.

canvas should be pasted over it and finished off with two coats of paint. If the piping is not exposed to vibration, the surface could be finished off with tar or left unpainted as desired.

It is always advisable to finish off a plastic covering with canvas, as the lagging soon breaks off if there is any vibration in the pipes, the interior in time becomes ground to powder, and the outside surface soon crumbles away. For low-pressure piping a good asbestos composition will do. This should also be finally covered with canvas. The usual thickness to which a magnesia lagging is applied is 2 in. for pipes above 5 in. bore, and not less than 1 in. for sizes below; this also applies for asbestos composition.

The best and safest way for ordering the pipe covering is for the draughtsman to send a print of the general arrangement of the steam piping to the makers, marking in red the extent of the piping to be covered, and, when asking for prices, to get them to quote a lump sum, and also per superficial foot,



ENGINEERING LAY-OUT.—FIG. 56.

so as to make a check on the estimate. The prices quoted by most covering makers include their men's time in putting on the canvasing. One ton of magnesia composition should cover about 160 to 170 superficial square feet, 2 in. thick, or 200 to 210 ft. super 1½ in. thick.

(To be continued.)

HYDRO-ELECTRIC POWER IN CANADA.

(Continued from page 197.)

Possible Power Sites.

On the St. Lawrence River below Lake Ontario, the first site where a development involving the whole flow of the river could be made is in the vicinity of Morrisburg. With a dam near the foot of Ogden Island, a head of about 11 ft. could be obtained, or, taking in a portion of the Galop Rapid, possibly a total effective head of about 15 ft. If utilisation of the Galop Rapid be contemplated, the question of regulating works to control the level of Lake Ontario has to be considered. In fact, for certain power developments on the St. Lawrence, the regimen of flow from, and storage in, each and all of the great lakes must be taken into consideration.

The next possible development is that at the Long Sault Rapids, where a head of about 35 ft. may be created. Some authorities state that the head which may profitably be developed is considerably less than 35 ft.; others, again, have thought that it might be increased to nearer 40 ft.

Descending the river we have next, in a stretch of about 14 miles between Lakes St. Francis and St. Louis, three series of rapids: the Coteau, the Cedars, the Split Rock, and the Cascades.

Coming next to the Lachine Rapids below Lake St. Louis, we have a head of about 30 ft. in 4½ miles. Here 17,000 H.P. is already being developed. The total undeveloped possibilities of the river at this point may be estimated at about 400,000 H.P.

The Cedars Rapids Manufacturing and Power Co. utilise at Cedars Rapid a head of about 32 ft., developed by means of a diversion canal some two

miles long. Ultimately, they will divert 56,000 second-feet. The power-house at the foot of the canal is designed for an ultimate development of 180,000 H.P. At present, units aggregating some 100,000 H.P. are installed, and extensions for the complete development are now being made with the immediate addition of two 10,000 H.P. units. This Company is exporting to the United States over 65,000 H.P.

The Soulanges plant of the Civic Investment and Industrial Co. is situated a short distance below the Cedars plant. Power is obtained by tapping the Soulanges Canal through an open headrace half a mile long, the development operating under a head of 50 ft. The installed capacity is some 15,000 H.P., the amount of water available for the plant being subservient to the requirements of navigation through the canal.

The St. Timothée plant of the Canadian Light and Power Co. is on the south side of the St. Lawrence, directly opposite the two last-mentioned developments, and utilises the descent of both the Coteau and Cedars Rapids. The water is led through a portion of the old Beauharnois Canal, seven miles in length. A head of 50 ft. is thus obtained. The development is for an ultimate capacity of 75,000 H.P., but the present installation is only for some 30,000 H.P.

At Mille Roches, the St. Lawrence Power Co. has a hydro-electric plant utilising a portion of the descent in the long Sault. The development includes a dam which forms an enlargement of the Cornwall Canal, with a short open flume leading to the power plant. The total capacity installed is 2,500 H.P.M., the equipment operating under a nominal head of 30 ft.

The Beach hydro-electric plant is situated at Iroquois, and utilises a head of about 12 ft. The present installation is for some 600 H.P. Extensions had at one time been planned to bring it to a total capacity of 2,400 H.P., but were abandoned as they would have seriously interfered with navigation.

There are also two hydro-electric plants at Morrisburg, having a nominal water-wheel capacity of about 1,250 H.P., and yielding about 900 H.P. under a head of 10 ft.

Estimated Low-Water Power.

To summarise, we may place the estimated low-water power of the international portion of the River St. Lawrence at about 800,000 H.P., of which Canada is entitled to one-half, or 400,000 H.P. The estimated low-water power on the portion of the river which lies wholly within Canada would be about 1,400,000 H.P. This, with its share of power along the international boundary, makes an estimated total for Canada of 1,800,000 low-water continuous horse-power.

By adjusting their deliveries, vendors of power are frequently able, during certain hours, to sell power which, during other hours, is used by another consumer. For instance, the Hydro-Electric Power Commission of Ontario, by taking into consideration what is technically known as the "diversity load factor" can, with a power capacity of 250,000 H.P., supply contract requirements of 320,000 H.P.; therefore, assuming such a basis for the St. Lawrence River powers, Canada's 1,800,000 H.P. would take care of a power demand of some 2,400,000 H.P.

The Export of Power to U.S.A.

Few people have any conception of what the 65,000 H.P., now being exported to the United States from the Cedars, could do if widely distributed to consumers of light and power. It is worth while to try to realise just what such an amount of power signifies. In 1916, a little less than 50,000 H.P. met the requirements for light and power of the 40,000 customers of the Toronto Hydro-Electric Power Commission. The rates for light and power in Toronto are low, much lower, for example, than in Montreal. Including the requirements of the Toronto Street Railway, the Toronto Electric Light Co., and the Toronto Hydro-Electric Power Commission, 120,000 H.P. is now required for light and power in the municipality of Toronto. Therefore, the 65,000 H.P. exported from the Cedars would, if retained in Canada, supply, at cheap rates, all the light and power required by a manufacturing city of 300,000 inhabitants. If distributed through Canadian municipalities, it would supply light and power to some 35 manufacturing cities of 10,000 inhabitants each; or it would practically take care of one-third of the present demands of the Niagara system of the Hydro-Electric Power Commission of Ontario, which supplies over 100 municipalities and 100,000 purchasers of electricity. A comparison of the benefits resulting from power thus widely distributed, with the localised benefits from the same power utilised in bulk, as in the electro-chemical industries, demonstrates that the former contributes in a much greater degree to the upbuilding of communities and to the growth of the country at large.

Now, if after taking the vital subject of Canada's coal supply into full consideration in its international aspect, it is found that the electrical energy generated in Canada can be retained for use here, results will be achieved which are unobtainable if the electricity is exported to the United States. Canadians should appreciate the fact that the United States has been dealing with them generously in the present distressing coal situation. Portions of the United States are as badly off for coal as portions of Canada. Between the United States and Canada there is an exchange of many natural and manufactured products, and the problems which arise, from time to time, in connection with such interchange can be satisfactorily solved, and the whole situation reduced to a good working basis. Canada, however, must conserve against the day of her own need such resources as are available for barter. These problems call for the best statesmanship which Canada can bring to bear upon them, and, only by a knowledge of all facts relating to the subject, can a wise administrative policy respecting our fuel and power problems be formulated and carried out.

(To be continued.)

Mr. W. G. Gardiner and Mr. F. C. Gardiner, shipowners, of Glasgow, have made a gift of £60,000 in order to endow three new chairs—one in bacteriology, one in organic chemistry, and the other in physiological chemistry. Principal Macalister stated that in the ordinances which would be proposed for the establishment of the new professorships they would be designated the Gardiner Chairs, in honour of the munificent founders.

DESIGN AND MECHANICAL EQUIPMENT OF OVERHEAD CRANES.

By H. Thornton.

(Continued from page 155.)

Compression Members of Warren Girders.

In designing compression members, such as the diagonals in a Warren girder, is not always wise to design them for crushing only. This is all right in very short struts, but long struts should be designed to withstand buckling, as they generally fail by this. Many designers use Euler's Law of Strength of Struts, namely,

$$W = \frac{\pi^2 E I}{L^2}$$

where W is the crippling load in tons, E = Young's modulus of elasticity in tons, I is the least moment of inertia of the section inch^4 units, and L is the virtual length of the strut in inches. The virtual length depends upon the condition of the ends of the strut.

If the section area of the strut be denoted by "A" square inches, then the crippling stress P, in tons per square inch, is equal to

$$\frac{W}{A} = \frac{\pi^2 E K^2}{L^2}$$

where K is the radius of gyration of the section in inches. When the strut is fairly short, the Rankin formula is, in my opinion, as reliable as any, which is

$$fp = \frac{fc}{1 + a\left(\frac{L}{R}\right)^2}$$

where fp = working stress per square inch,

fc = safe compressive stress,

$a = \frac{1}{6000}$ for mild steel,

$\frac{L}{R}$ = buckling factor.

This formula only applies where $\frac{L}{R}$ is *less* than 180.

The deflection of *each* girder due to the *load* coming on it, *i.e.*, 0.5 (Q + QR), and its own weight $q\,l$ is determined from the equation

$$\delta = \frac{(Q + QR + \frac{5}{8} q l)\, l^3}{48\, EI}$$

where Q = load, l = span, QR = weight of crab, E = 29,000,000 lbs. per square inch, I = moment of inertia, and Q and l are in pounds and inches respectively.

Working Stresses.

The practice of fixing the working stresses at a certain amount for all cranes, or for all parts of the same crane, is most unsatisfactory. The safe working stress to be adopted in designing the principal parts of a structure depends in some way upon the variation of stress to which the parts are subjected, and not upon some old-fashioned "Factor of Safety."

Adopting a factor of safety of 3 in all cases, and assuming the breaking weight of steel to be 30 tons per square inch, Prof. Lilly's formula is

$$\text{Maximum stress} = \frac{\frac{1}{2}\ \text{breaking weight}}{1 - \frac{1}{2}\,\frac{\text{minimum stress}}{\text{maximum stress}}}$$

which becomes

$$\text{Working strength} = \frac{5}{1 - \frac{1}{2}\,\frac{\text{minimum stress}}{\text{maximum stress}}}$$

For instance, if a certain member is subjected to a pull varying from 2 tons to 6 tons, the working strength would be taken at

$$\frac{5}{(1 - \frac{1}{2} \times \frac{2}{6})} = 6 \text{ tons per square inch.}$$

Had the member been subjected to an *unvarying* pull of 6 tons, a working strength of 10 tons would

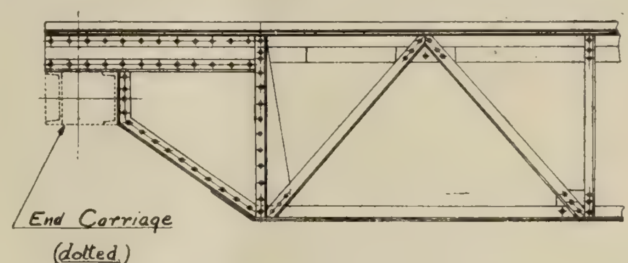


Fig. 8.—Design and Equipment of Cranes.

have been adopted; again, if the member had been subjected to a pull varying from 0 to 6 tons, the working strength would have been 5 tons per square inch and so on.

End Carriages.

In order to calculate the strength of the end carriages, it is necessary to find the maximum track wheel pressure occurring when the crab is at the extreme end of the cross girders, and multiply this pressure by the distance from the centre of the track wheel to the centre of the first girder as it sits upon the end carriage. This gives the maximum bending moment, and the channels or other forms of end carriage are designed to suit the bending moment

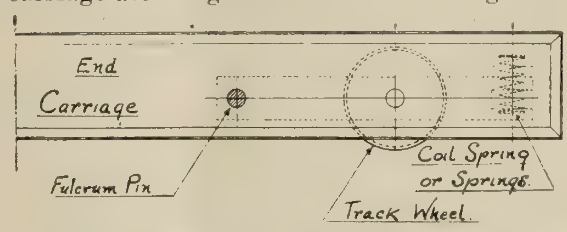


Fig. 9.—Design and Equipment of Cranes.

found, stressing the material to about 5 tons per square inch, in good practice.

The method of attaching the main girders to the end carriages is a detail of some importance. There are many systems in common use, depending to a great extent on the head room and side clearances available. For all-round work, it is usual for the girder to be "stepped" at the end to fit on the top and side of the end carriage, as shown in Fig. 8.

The design of the end carriage must be such as to prevent the bridge falling in the event of the crane leaving the track, or an axle or wheel breaking.

Wheel Base.

In normal cranes the end carriage wheel base is seldom less than one-fifth of the span, but in cases where the travelling speed is very high or the span short, a longer wheel base is necessary. It is the practice of some crane makers to fit spring end carriages to all cranes travelling at a high speed, say, over 400 ft. per minute. In this type the track wheels are fitted between steel plates which act as levers, the track wheel in most cases being between the fulcrum pin and the springs, as in Fig. 9. Large coil springs are generally used for this purpose.

(*To be continued.*)

INDUSTRIAL LIGHTING.

Improvement of Machine Lighting by the Use of Paint.

A good overhead system of lighting is the modern standard for industrial establishments, and usually provides all the light that is required for the lighting of most interiors. Quite frequently, however, local lighting is employed in addition to the overload lighting for certain machines or locations in the shop.

To assist local lighting it has been found that the use of white paint has proved very effective. In one case a large machine room containing massive vertical slotters was lighted with an overhead system to

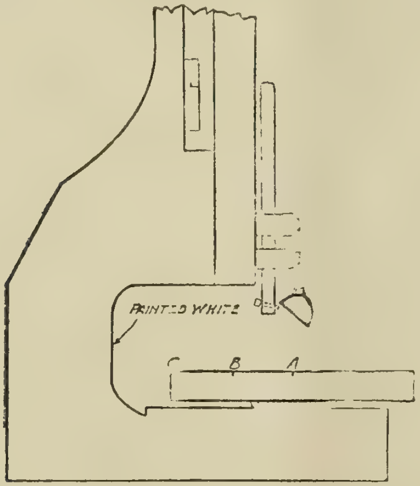


Fig. 1.

an average intensity of about two-foot candles. The heavy machines were finished with very dark paint, so that the lighting of the tables in the region where the cutter operated was insufficent for setting the cutter accurately to the pencil markings on the rough castings ready to be machined. As a remedy, a lamp on a drop cord was provided for each machine, and the surfaces of the machine which faced the table were painted white. This improvement avoids any shadows from the local lamp, as the reflection from the white painted surfaces softens the shadows very materially and increases the illumination on the table by about 75 per cent (see Fig. 1). The foot-candle meter readings taken at the base plate showed an improvement with the use of paint of 100 per cent in the lighting at the points A and C, and over 50 per cent at the point B.

Owing to the present necessity for strict economy by reason of the coal restrictions, the use of white paint would appear to be a most desirable practice for all machine and workshops.

SOLVING THE PACKING PROBLEM.

Of all the attempts to solve the packing problem, nothing has been so successful as the "M-ten" Collapsible Crates and Boxes, made by Messrs. Madgwick Ltd. These are so ingeniously constructed that they are perfectly rigid and stronger and less liable to damage than the old-fashioned nailed-up Crates and Boxes. When empty they can be collapsed for return as empties. All parts are interchangeable, and any damaged portion can be immediately replaced. They effect a saving of 80 per cent in storage room—a valuable consideration in itself—and goods carried in them are taken at Railway Company's risk. Another feature is that they are pilfer-proof, because each part interlocks with the other, and no part can be removed for the purpose of extracting the contents. These crates and boxes have stood the test of two years' usage by large numbers of manufacturers, and the demand for them is growing daily. Messrs. Madgwick Ltd., of 21-22, East Row, N. Kensington, London, W 10, are the sole makers and patentees of the "M-ten" Collapsible Crates and Boxes, and they offer to send a specimen Crate or Box on request to all enquirers.

INSTITUTION OF AUTOMOBILE ENGINEERS.

At the Council Meeting of the Institution of Automobile Engineers, held on the 5th February, Mr. Thos. Clarkson, of the National Steam Car Co., Chelmsford, was elected president of the Institution for the Session 1919-1920, and will take office on the retirement of the present president, Mr. A. A. Remington, in 1919.

The new vice-presidents of the Institution are Mr. L. H. Pomeroy, Mr. H. G. Burford, and Mr. G. Watson.

Plans are on foot to increase the work of the Institution and bring members into closer touch with each other, and it is hoped that arrangements may be made for a special session during the Olympia Show.

The Coventry Graduates continue their successful meetings, to which appreciable dignity has been added by permission granted to use the Mayoress's Parlour in the Town Hall for the meetings. There is no doubt that there is a great deal to be gained by dignified surroundings for technical meetings.

The election to the grade of honorary members of the Institution has been very closely guarded, and the list up to the present consists of only two names—Mr. Howard Marmon, who was president of the Society of Automotive Engineers on the occasion of the visit of the Institution to America in 1913, and Major W. G. Wilson, to whom so much credit for the design of the Tanks is due. Honour has now been paid to two other gentlemen whose names are well-known in connection with the internal-combustion engine, and Dr. Watson W. Watson, D.Sc., F.R.S., and Professor H. L. Callendar, M.A., LL.D., F.R.S., have now been elected honorary members of the Institution.

It is announced that owing to the increased expense of printing the proceedings, and the shortage of some of the earlier volumes, these will now only be obtainable at an increase of 10 per cent for each year that a volume has been issued, up to 100 per cent, *i.e.*, that a volume 10 years old, instead of being procurable for £1 1s., will now cost £2 2s.

The monthly meeting was occupied with the reading of a most valuable and topical Paper by Mr. G. D. Leechman, entitled "Efficient Invention, which not only contained a number of most useful hints to inventors, but also dealt in an

admirable manner with the alterations which are so obviously required in the present Patent Laws.

The Institution has, during the past two sessions, accepted a number of Papers on subjects which are not strictly technical, but the Council feel that it has followed a useful line in thus tackling subjects which are of very practical interest to the automobile engineer.

Trade Items, Notes, &c.

The Royal Agricultural Society of England, after an interval of two years, has now issued the prize sheet for live stock, produce, implements, etc., at the show of the Society to be held at Cardiff, from Tuesday, June 24th, to Saturday, June 28th. The total value of the prizes offered (inclusive of champion prizes, special prizes, and medals), is £10,800, of which £1,035 are contributions from the Cardiff Local Committee, £3,547 from various breed societies, and £505 10s. from other sources.

According to Lloyd's Register there were 424 merchant vessels of 1,979,952 tons gross under construction in the United Kingdom at the close of the quarter ended December 31st. This is about 233,000 tons more than was in hand at the end of September, and about 113,000 tons more than a year ago. Four vessels are between 20,000 and 25,000 tons. Other countries are building 1,765 ships of a gross tonnage of 4,942,037, bringing the merchant ships under construction in the world up to 2,189, of a total tonnage of 6,921,989.

Sheds formerly constructed of corrugated iron have during the war been built of reinforced concrete, and have the advantage of being cooler, and less likely to be infested with rats. They are easily cleaned with water from a hydrant, offer resistance to burglars, are more durable, and of neat appearance when properly designed. These buildings have, however, the disadvantage of being heavier, and therfore require more expensive foundations were the ground is bad, they are not portable, and the concrete may crack and become leaky.

A contract for the construction of 35 locomotives has been placed by the Government with Messrs. William Beardmore Ltd. The importance of this order is fully appreciated, and the work will immediately be put under weigh in the shops at Dalmuir, probably in the department given over until quite recently to the manufacture of gun-carriages. Locomotive building has not hitherto been a speciality in Messrs. Beardmore's works, but the necessity at the present is so great that advantage must be taken of every possible means of increasing the number of railway engines.

There seems to be a fair prospect of the Kearney Tube at Woolwich obtaining the approval of the Light Railway Commission, there being little or no opposition to the proposal. The locality seems well chosen, as there is plenty of traffic and little competition for it. It is to be hoped, as a matter of engineering interest, that the line will be built and run, because Mr. Kearney's proposals and his claims for them really require experimental trial on a full-size scale to prove whether they represent a real advance in railway practice, and how much any proved advance is worth.

Although oil has not yet been found in considerable quantities in Western Canada, the discovery of petroleum, particularly in the Viking area and the Peace and Athabaska Valleys, is referred to as more than possible by the assistant to the chairman and deputy-head of the Canadian Commission of Conservation. The finding of oil in the Pelican Rapids gas well, and a small quantity of dark oil obtained in one of the wells in the Viking gas field, are mentioned as encouraging indications. The book states that seepages of oil have been found near Waterton Lake, in South-Western Alberta, and in the Flathead Valley, in South-Eastern British Columbia.

The annual examinations for a Faraday Scholarship of 50 guineas per annum, tenable for two years in the Electrical Engineering College and one year in manufacturing works, and for a Maxwell Scholarship of 50 guineas per annum, tenable for one year in college and one year in works, will be held at Faraday House on April 15th, 16th, and 17th. Exhibitions may also be awarded to candidates who acquit themselves creditably in the above examinations. The subjects of examination for the Faraday Scholarship are geometry, algebra, trigonometry, dynamics, statics and hydrostatics, geometrical and freehand drawing, chemistry and physics. For the Maxwell Scholarship, the subjects are mathematics, dynamics, statics and hydrostatics. Particulars can be obtained from the Secretary, Faraday House, Southampton Row, London, W.C.1.

The Austrian Iron Industry.—The extent of employment in the Austrian iron industry varies greatly just now. The Alpinen Montangesellschaft, the steel works Gebrueder Hoehler and Co. A.G., the Ternitz steel and iron works of Schoeller and Co., Johann Bleckmann, Rudolf Schmidt and Co., and other works and foundries situated in Germano-Austrian territory are all greatly hampered by the contiued lack of coal. Most of the blast-furnaces are still closed down. The Prager Eisenindustrie Gesellschaft, Poldihuette, Witkowitzer Bergbau and Eisenhuettengewerkschaft, Oesterr. Mannesmannroehren Werke, and other establishments in the Czecho-Slav districts are also insufficiently supplied with coal, but are managing to keep going. A vital question, however, is the supply of iron ores, which were hitherto obtained from Styria. Sales of iron goods are poor, as building operations have not yet recommenced, whilst despatch to former provincial and neutral markets is suspended by the lack of transport facilities. The collieries and blast furnaces at Teschen and the firms of Albert Hahn Eisenwerke of Oderberg, and the iron and steel works at Freistadt, now occupied by the Poles, are still working, but sales are also hanging fire as East Galicia is cut off, whilst West Galician buyers are very reserved in placing any orders. Prices of bar iron have advanced Mk. 110 per 100 kilogs.

New Substitutes for Platinum.—Of late, various new substitutes for platinum have been introduced in Germany, the principal of which deserve some brief mention. The most important one of all appears to be a Wolfram-gold-nickel alloy introduced by Gotthold Fuchs, of Berlin; it is intended for ornamental, industrial, and technical uses, as it can be cast, wrought, or rolled, and possesses a bright colour. When polished it becomes very brilliant which, as is well known, is not a virtue possessed by platinum itself. Another similar alloy consists of silver, wolfram, and nickel. This, as well as the gold alloy, is said to possess a marked degree of acid-proof power. In manufacturing these alloys, at least one of the precious metals used is employed as an intermediate alloy with nickel. A nickel-iron alloy, known as "Platinit," is said by a Dutch manufacturing firm to afford an excellent substitute for platinum in the manufacture of electric incandescent lamps, as its coefficients of expansion correspond to those of the glass itself. In laboratories an alloy of nickel and chromium is being used as a substitute for platinum, but much better results (especially for articles required to be acid-proof) are obtained with such cobalt alloys as cobalt-iron and cobalt-chromium. For crucibles an alloy of gold and platinum was proposed already some 10 years ago, but this is now being superseded by a gold and palladium alloy called "Palan." This is said to be fully equal, if not superior, to platinum in its wearing qualities. When making analyses with such crucibles and melting pots it should always be obrne in mind that traces of gold and palladium may always be present.

Hydraulic Power in Spain.—A Spanish specialist in all matters relating to hydro-electric power has just published a very interesting report dealing with the actual situation of the hydraulic power industry in the Iberian Peninsular. It is more especially pointed out that the laws and regulations concerning hydro-electric plant do not correspond at all to the actual requirements of this industry. This existing legislation is, as a matter of fact, quite out of date and, as a rule, only regards the utilisation of water-courses (regarded as the property of the State for irrigation purposes) either for purposes of navigation or for the supply of portable water. Questions dealing with the utilisation of hydraulic energy are merely regarded as matters of secondary importance. All concessions are granted "in perpetuity" without any restrictions whatsoever, so that about 80 per cent of the water-falls not yet exploited are in the hands of greedy speculators eagerly awaiting opportunities to sell to the highest bidder. However, both in Spain and France, the question of water-power will be earnestly taken in hand shortly; coal is scarce, and it is folly to buy it at dear prices from foreign countries when there are hundreds of rivers and water-falls whose power is now running to waste, whereas, if properly utilised, it would solve many vital industrial questions. Steps are to be taken in Spain to change legislation to bring it more in line with modern requirements

Reviews.

"Mensuration Made Easy: or, The Decimal System for the Million," by Charles Hoare. Price 1s. net. Effingham Wilson, 54, Threadneedle Street, London, E.C.2.

This little book has been compiled to meet the requirements of those who are not accustomed to figures, and refers, as far as possible, to those mathematical problems encountered in the daily employments of the artisan and mechanic. It is written in such a way that even the most humble aspirant cannot fail to understand and master its contents, taking him through from the simplest rudiments to that stage which should enable him to solve many of the most important problems in mechanical science. We can highly recommend this little work to those who require a simple book of instructions on mensuration and the decimal system, and we congratulate the author on producing a little work which should no doubt fill a long-felt want on the part of those who have not been favoured with a liberal mathematical training.

Publications.

No doubt some of our readers at times require a lacquer, varnish, or enamel for some specified purpose. **Messrs. Jenson and Nicholson,** Goswell Works, Strattord, London, E.15, who have been established over 97 years, have a wide reputation, and have published a brochure briefly describing their several specialities, and the various purposes to which they can be put. A special booklet is issued with reference to their varnishes and enamels, as supplied to the electrical industry, the insulating properties of which we believe are highly commended. These can be purchased either for stoving or air drying. The firm wish it to be understood that although their standard articles, in most cases, meet the general needs of their clients, their explicit advice is readily extended to any special requirements.

The Davis Furnace Co. Ltd., Diamond Foundry, Luton, heating engineers and fuel specialists, in their circular, D.O. 18, describe and illustrate their specialities in drying ovens suitable for lacquering, stoving, varnish drying, and any other operations carried out at temperatures up to 500 deg. Fah. These stoves can be supplied in various types, the most usual being either double or treble-cased patterns. In the latter the products of combustion circulate round the inner casing, so that the burnt gases do not in any way come in contact with the work to be heated; the outer cases being substantially insulated with a non-conducting material in all their drying apparatus. Heating is effected by natural-draught burners for consuming gas at ordinary main pressure, but the burners can be arranged for operation with producer gas, if necessary. A thermometer is provided for each oven, for the purpose of temperature regulation, which it is stated can be very accurately effected. A table of standard sizes is given, but the company are prepared to quote for any special size to suit individual requirements.

The Ludlum Steel Co., of Watervliet, New York, is one of the oldest-established high-grade tool steel mills in America. Founded in 1854, it has grown from a comparatively small crucible plant to one of the largest producing mills in the country. This firm claim to be one of the pioneers in the use of the electric furnace, and have subsequently developed a special form of "Electric Crucible Furnace," from which it is stated a very fine grade of steel is produced. A book of 150 pages is published with reference to their products, and contains much information regarding the manufacture, forging, grinding, and the heat treatment of the various steels. A section of this book is devoted to some very useful data concerning weights of steel bars, tempering tables, thermometer conversion tables, etc., and other miscellaneous matter.

Two little pamphlets are published by **The British Acetylene and Welding Association,** 103-4, Cheapside, London, E.C.2, price 6d. each, entitled "Defective Acetylene Welds" (by Captain Richardson, R.A.F., Wh. Exh., A.M.I.M.E.), and "The Impurities in Acetylene" (by Charles Bingham, C.E.). These papers were read by their respective authors before the quarterly general meeting of the Association, the former dealing with the various causes of defective welds, comments on the general lack of efficient attention to plant, and points out most strongly the necessity of employing suitable apparatus, and highly-skilled operators. The latter paper relates to the effect that various impurities have on welding, and how they may be illuminated. These are two interesting little papers, and we appreciate the remarks of the respective authors concerning the efficient and safe promotion of an industry that has such a field of service.

Queries and Replies.

We shall at all times be pleased to help our readers out of their difficulties to the best of our power, and invite them to make use of this column for that purpose.

Utilising Exhaust Steam.—The writer would be glad of some advice *re* the possibility of introducing a modern steam turbine, utilising the exhaust steam from a Compound S.C. Tandem Horizontal Engine: cylinders $18\frac{1}{8}$ in. and 34 in. diameter × 36 in. stroke. The working pressure is 120 lb.; revolutions, 78; vacuum, 25 in. The steam is superheated to a total heat of 600 deg. Fah. What power might be developed by the turbo-generator under the conditions?

Reply :—

The increased output that can be obtained by the installation of an exhaust steam turbine is dependent upon the vacuum, which should be higher than that specified. It is common knowledge that a turbine can take advantage of a high vacuum, whereas owing to the mechanical difficulties presented by the undue size of the low-pressure cylinders of a reciprocating engine, the volume of steam becomes too great to be efficiently dealt with after the vacuum exceeds 25 in. With a turbine, on the other hand, there are no ports and slide valves, and as the steam is always in motion very large volumes can be accommodated, and the highest possible vacuum is therefore permissible and desirable. It is owing to the fact that a turbine is capable of taking advantage of a high vacuum that the installation of an exhaust steam turbine will increase the output of a plant without increasing the fuel consumption. With the vacuum specified in the question the engine is capable of using the steam energy, but if the vacuum were increased to, say, 28 in., the conditions would be different. If, for instance, we take the steam pressure mentioned and neglecting the superheat, it will be found from steam tables that on expanding this steam to atmospheric pressure (14.7 lbs. absolute) the energy available is 162 B.Th.U.'s per pound of steam, and when further expanded from atmospheric pressure to a vacuum of 28 in. the extra available energy in British thermal units amounts to 150, so that theoretically there is nearly as much energy available in the low-pressure range of expansion as in the high-pressure range. To arrive at any accurate estimate of how much power an exhaust steam turbine will develop, however, it is necessary to know the steam consumption of the existing engine, for this, of course, determines the amount of steam which the turbine receives, and if the actual steam which the engine uses per hour is unknown it should be tested. Having obtained this quantity of steam it is then a simple matter to arrive at how much power a turbine will develop, assuming, of course, that a suitable condenser is used which will give a good vacuum. Usually the turbine and engine are arranged so that the normal full load of the engine is maintained; notwithstanding that when connected up to the turbine it runs non-condensing with a back pressure of about 16 lbs. absolute. It is to be observed that this involves supplying more steam to the engine than it received before, and this must be taken into account when estimating the additional output to be derived from the turbine. The steam consumption will be about 35 per cent greater when running non-condensing, and this total quantity of steam is, of course, the quantity that has to be taken into account. About 10 per cent, however, must be allowed for losses due to condensation and, say, another 5 per cent for other losses. Tests show that an exhaust steam turbine consumes about 40 lbs. of steam per kilowatt, so that the total quantity of steam arrived at as above, divided by 40, will give a fairly accurate idea of how much additional load the exhaust turbine will develop. The output of the engine may generally be maintained by altering the valve setting so as to make the cut-off later in the high-pressure cylinder. It will, of course, be understood that the higher the vacuum the better the gain, and up to now a vacuum of about 28 in. has been assumed. It has been found that on an average the exhaust steam from the engine (maintaining its original load) will give an additional output in a low-pressure turbine of 61 per cent of the output of the engine at 27 in. vacuum, 70 per cent at 28 in., and 81 per cent at 29 in. These results are based on electric power station practice.

J. Humphrey.

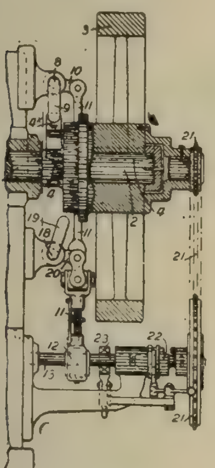
Patent Applications.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

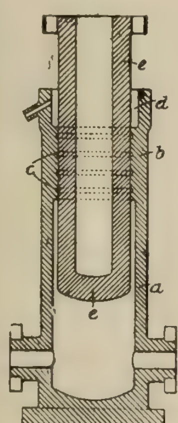
ABSTRACTS OF SPECIFICATIONS.

OPERATING CLUTCHES.

119,139.—A. WHITEHEAD, 206, Upper Wortley Road, Upper Wortley, and A. W. GLOVER, Holbeck Engineering Works, Holbeck Lane, both in Leeds.—Nov. 9th, 1917.—Clutches of the rotating-pin tpe for use in power presses such as printing presses and presses for stamping or embossing cardboard caps, etc., are automatically operated in such a manner as to produce intermittent half-revolutions of the driven shaft. The slide-operating shaft 2 carries a segmental clutch-pin 4x normally engaged by a spring to move the pin to clutching position and clutch together the rotating fly-wheel 3 and the shaft 2 but adapted to be stopped at the top and bottom of its rotation by levers 9, 19 to disengage the clutch and stop the shaft. The fly-wheel 3 continuously drives through chain-gearing 21 a shaft 13 which carries an eccentric 12 operating a jointed bar 11 connected by levers 10, 20 to pins 8, 18 carrying the levers 9, 19 which are moved alternately into the path of the arm 4x so as to stop the shaft 2 for a period and then release the arm to allow another half-revolution of the shaft. A clutch 22 and brake 23 are used for stopping the rotation of the shaft 13. The pins 8, 18 are spring-cushioned to prevent shocks when the arm 4x strikes the levers 9, 19.



Patent 119,139.



Patent 119,145

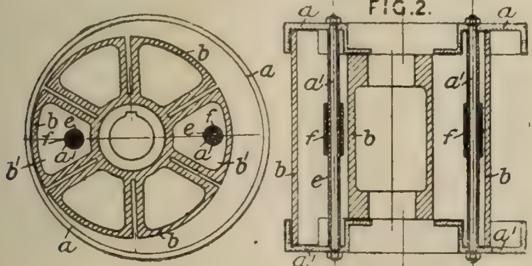
RECIPROCATING PUMPS.

119,145.—CHANCE AND HUNT, Chemical Works, Oldbury, and O. E. MOTT, Research Department, Royal Arsenal, Woolwich.—Nov. 16th, 1917.—A pump for corrosive liquid comprises a cylinder *a* and a plunger *e* made of acid-resisting material, the cylinder-head *b* being provided with packing-grooves *c*. Leakage past the grooves *c* is caught in a chamber *d*.

ROTARY BLOWERS, ETC.

119,158.—F. LYON, 24, Churchill Road, Bordesley Green, Birmingham.—Dec. 10th, 1917.—Relates to blowers and the like having a rotary drum *b* and flanged end plates *a* of the kind described in the parent Specification, and consists in bracing together the

FIG.2.



plates *a* by means such as tie-rods *a*1 fitted with distance sleeves *e*. In modifications, the parts *a*1, *e* are replaced by shouldered tie-rods or internally-threaded distance-sleeves taking end set-screws. Additional sleeves *f* may be fitted to prevent the walls of the spaces *b*1 from contacting with the distance-pieces, etc., *e*.

WRENCHES.

119,151.—J. ASHTON, 17, Hawksley Road, Hillsboro', Sheffield.—Nov. 29th, 1917.—A hand-grip pipe wrench or the like of the type comprising two handle members provided with jaws, passing one through the other, and pivoted one to the other by notches in the front or rear edge of the inner member engaged by a pin fixed in the outer member, has a spring on a fixed pin to hold the members in closed position, one end of the spring engaging the front face of the lower jaw piece, and the other the front edge of the shank of the upper jaw. As shown, the inner member A1 having a jaw A2 is formed with notches A3, any one of which may be engaged by a pin B4 fixed in the outer member B which is bent into U-shape in section and has a filling-piece C in the jaw-end B1. A spring E embracing a fixed pin B5 in the member B, has one end E2 engaging the front face of the filling-piece C or a recess therein and the other end E1 pressing against the edge of the member A1.

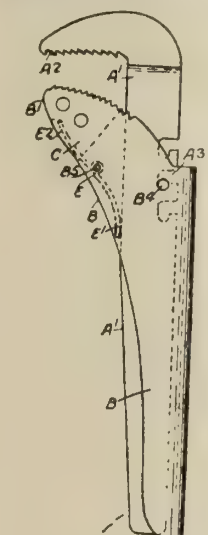
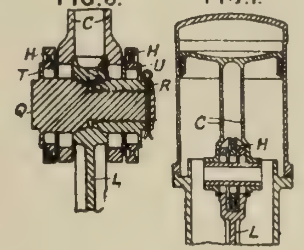


FIG.6. FIG.1.



Patent 119,151. Patent 119,157.

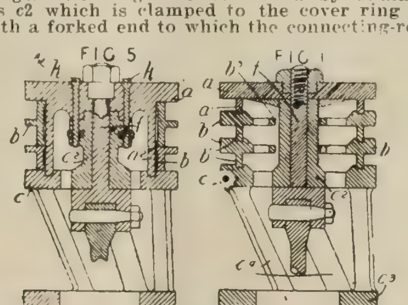
ENGINE AND LIKE CROSS-HEADS.

119,157.—J. W. DRAPER, 1, Appleton Gate, Newark-on-Trent.—Dec. 7th, 1917.—In an internal-combustion engine, steam engine, pump or compressor, one roller or two rollers mounted on the gudgeon engage guides, the distance apart of which is less than the diameter of the cylinder. When a single roller H is employed as shown in Fig. 1, both the piston-rod C and the connecting-rod L are forked, the roller being mounted in the fork of the connecting-rod. The guides for the roller H are mounted in the neck of the crank casing. When two rollers are employed, one rod only is forked. In the form shown in Fig. 6, a coned head Q on the gudgeon and a coned nut R engage coned openings in the connecting-rod L, roller bearings being inserted between the gudgeon and the bearings in the forks C. Roller bearings for the guide rollers H are retained by flanges T, U. Alternatively, the head Q and nut R may engage coned openings in the forks C. A cylindrical gudgeon may be employed, secured either in the piston-rod or in the connecting-rod, roller bearings being employed between the gudgeon and the other rod. The rollers H may be arranged either outside the forks C of the piston-rod or between the forks C and the connecting-rod.

PISTONS.

119,183.—A. SOETENS, 29, Govan Drive, Alexandria, Dumbartonshire.—Feb. 11th, 1918.—The piston is built up of rings *a*, *b*, *c*, Fig. 1, spaced by flanges *a*1 *b*1 which enter grooves in the adjacent rings. The ring *c* is connected by radial webs to a central boss *c*2 which is clamped to the cover ring *a* by a bolt *f* formed with a forked end to which the connecting-rod is pivoted.

FIG 5 FIG 1



The rings *b* are connected by radial webs to strengthening rings *b*3, and the ring *c* is connected by inclined webs *c*4 to an extension ring *c*3. In the modification shown in Fig. 5, the piston body consists of two rings *a*, *c*, the flange *a*2 of the ring *a* carrying the carrier rings *b* for the piston packing. The central boss *c*2 of the ring *c* is secured to the cover ring *a* by side bolts *k* in addition to the central bolt *f*.

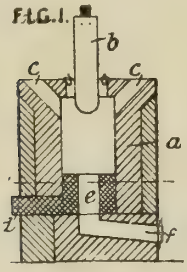
ELECTRIC INSULATORS.

119,166.—SOCIETA CERAMICA RICHARD-GINORI, 115, S. Cristoforo, Milan, Italy.—Dec. 27th, 1917.—The electric insulator described in the parent Specification has a very thin layer of rubber or equivalent elastic and plastic substance interposed between the insulator and its electro-deposited metal sleeve. The elastic substance is preferably applied in the form of a solution from which the layer is deposited by evaporation of the solvent. The elastic layer is rendered electrically conducting by the application of powdered graphite or metallic powder.

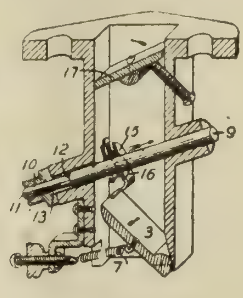
CARBON; ELECTRIC FURNACES.

119,164.—S. E. SIEURIN, Höganäs, Sweden.—Dec. 15th, 1917.—Anthracite, coke, or other carbonaceous material is converted into a product suitable for the manufacture of furnace electrodes by heating it in an electrode furnace to a temperature between 1800 and 2000 deg. Cen., which is a little below that of graphitisation. An energy consumption of 1,000 kilowatt-hours per ton is sufficient, that is, about a third of that generally necessary for transformation to graphite. As shown, the furnace may comprise a short shaft *a* with an upper electrode *b*, inclined charging passages *c*, and one or more bottom electrodes *d*. An opening *e* through or beside the bottom electrode, or between several electrodes, leads to a discharge passage *f*.

FIG. 1.



Patent 119,164.



Patent 119,180.

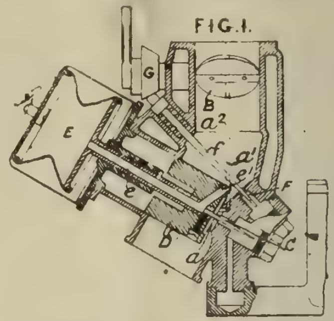
INTERNAL-COMBUSTION ENGINES.

119,180.—A. E. COOK, 136, Pitt Street, Leith.—Feb. 5th, 1918.—The air and fuel supplied to a spray carburettor are controlled simultaneously by connecting a hinged flap 3 in the air inlet to a fuel valve 10 having a tapered groove 11 of variable depth. The flap 3 is loaded by an adjustable spring 7 and is connected through fork members 16 and adjustable collar 15 to an extension 9 of the valve 10. Between the valve 10 and its extension is a conical valve 12 which, in its closed position, is seated on the bush 13. The free end of the flap 3 may be V-shaped or rounded, the carburrettor casing being formed accordingly. The throttle valve 17 may be connected to the valve spindle.

INTERNAL-COMBUSTION ENGINES.

119,187.—WOLSELEY MOTORS LTD., E. REEVE, and A. A. REMINGTON, Adderley Park, Birmingham.—Feb. 15th, 1918.—In a carburettor in which a suction-actuated weight valve D controls the main air and fuel supplies, a small air passage *a*, *a*1 passes across the outlet end of the main fuel nozzle C and communi-

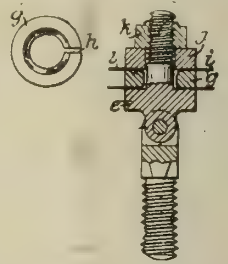
FIG. 1.



cates with the throttle chamber at a point *a*2 near the edge of the throttle valve B. An auxiliary fuel nozzle F is controlled by a needle valve *f* controlled by a cam G on the spindle of the throttle valve. The nozzle F is placed in the direct current of air past the valve D, and also in the current from the passage *e*, *e*1 leading from the bellows E controlling the valve D. Specification 9240/12 is referred to.

CLEANING TUBES.

119,203.—P. GEORGE, 63, Kingsley Road, Shirley, Southampton.—May 7th, 1918.—In a tube-scraper of the steel-bristle type, U-shaped



bristles *i* are fitted on a split ring *g* supported on a pivoted head *e* and secured by a nut *k* and washer *j*. The bristles may be removed and replaced through the slit *h* in the ring.

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— THE —

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CONTENTS.

EDITORIAL.

PIECEWORK AND SUPERVISION.

A very singular misconception, which is widespread enough to call for notice, is that piecework obviates the need for supervision. It is perfectly true that where a man is paid exactly what he earns there is less need for his foreman to act policeman, but production and supervision are much more than detection of the slacker. Piecework methods involve more oversight, since quality of work suffers severely unless closely supervised. Actually, therefore, supervision is more necessary where piecework is in vogue, it is supervision of product, not supervision of effort, which is required if the prices are rightly set. The less competent the labour the higher the cost of supervision, for in addition to oversight, it includes tuition. Further, since increased output is the goal and lessened cost the end, organisation must serve to avoid idle time.

There is often a tendency to resent an extra week's wages, whereas the contrary should be the case. Such resentment sometimes takes the form of impediments to fully occupied time, the pieceworker is kept waiting at intervals to his own justifiable resentment, and this impairs output. Action of this character on the part of the shop executive is very shortsighted. Often the pieceworker is compelled to add to the work for which he is paid, because, not being kept supplied with material, he has, by personal effort to fetch it. In one instance drillers were kept without drills because their earnings were high, and as a consequence had to buy their own. Such provision was not part of the contract, and practices of this kind do not improve the relations between the man and the management.

While payment by results is the most vexed of industrial problems, there is a sense of right dealing and common justice which it is folly to breach. The outcome is apt to be lamentable; it deteriorates product and gives rise to feelings of injustice which smoulder to a subsequent breach of the peace. In another instance where a range of sizes are produced, the small has to pay for the large, or *vice versa*, and any protest is met by a statement to this effect. In deed and fact, this is supervision of the poorest kind, and is in the same street with allowing facilities to datal workers, and withholding them from pieceworkers, instances of which have been common enough.

If a man can produce double and earns double, he is cheaper than two men producing equal quantity. To double output with the same number of men, even if it involves a higher supervision cost, is cheaper than doubling the plant. Good organisation has, in some instances, had even better results. It means greater profit on the same capital expenditure with everyone satisfied and contented. The management because of increased turnover, the man because of double wages. To resent the latter and expect the former is very poor reasoning. Expansion of plant and buildings may look a prosperous proceeding, but before this is projected it is worth while to consider rearrangement, better organisation, and greater individual output.

Piecework demands closer supervision not merely to ensure quality, but to aid production: it is no substitute for brains in management. Because a man has to earn exactly what he receives is not an alternative for good staff work higher up, but an in-

centive to make this of such a character that the man can lay no charge against the management if his earnings are not decidedly higher under payment by results. In piecework there are two parties to the contract, and observation has shown that while actual prices are a cause of friction, a much greater cause is idle time, pointing to defective organisation on the part of the other contracting party. It is this side of the case which most often requires amendment, and modern methods, with their complex schemes of payment, do at least realise that the price paid is a rate set dependent upon foresight and adequate provision. In other words, piece prices are not a substitute for supervision.

LABOUR AND LICENSE.

When any system evolved through long periods of time is suddenly discarded, the reaction produced is explosive, and unlikely to discriminate with any nicety. In the course of industrial erection, as in the case of any other architecture, compensations and adjustments are made by the craftsmen, and no design is initially so perfect that skill is thereby avoided. Trade and commerce are very delicate instruments of human activity and, like the tide on the sea shore, cannot by mere command be made to vary their appointed task. In like manner, if either labour or management abrogate the underlying economic laws, they are bound to suffer for the breach. Mutually interdependent, it is their cooperation in cheerful and willing spirit which makes successful industry. History teems with instances where laws have been passed in restraint of trade, either in a sumptuary sense, or from national motive. In every instance economic truth has beaten the legal prohibition. It may indeed safely be said that a law to be valid must be in accordance with common sense, and the vast majority of the populace must acquiesce, otherwise the statute becomes a dead letter. It may be unrepealed, but by common consensus is non-existent. Legislation cannot be far in front of realised public opinion. No state of civilisation, and no condition of industry, can be final, or a summation of perfection. Other days, other manners, applies to industrial conditions as to custom and usage.

The trouble is that at the moment a considerable minority of the community believe that it is only necessary to have legal enactment to secure exceptional privilege. They think that profit is a fixed amount, whatever may be paid for production. Another fallacy is that the minimum production ensures the largest amount of labour and less unemployment consequent upon production being a fixed and unvarying necessity. Both are fallacious beliefs; there is a point at which industry becomes unproductive, not merely is the profit eliminated, but the employer. After all, profit is a fee paid for unemployment; in most industries it is not inordinate, in the key industries it is relatively small, and as upon these industry as a whole rests it is essential first, that the reward shall be sufficient, in the second that the industry shall prosper in the direct interest of labour, its greatest charge.

If profits are legislated away, and labour given uneconomic payment, there is no incentive to shoulder the burden and heat of the day, no extra payment for extra hazard and risk taken in the prosecution of trade; the employer, after all, underwrites the risk, and for this his commission is by no means excessive.

A NEW THEORY OF PLATE SPRINGS.

By David Landau and Percy H. Parr.

(*Continued from page 194.*)

Now, referring to Fig. 7, it will be seen that for the $n+l$th plate, we must have; for

$$o \leqq x \leqq l_n$$

$$M = EI_n + 1 \frac{d^2y}{dx^2} = W_n + 1\,(l_n + 1 - x) - W_n(l_n - x) \ldots\ldots (2)$$

and for
$$l_n \leqq x \leqq l_n + 1$$

$$M = EI_n + 1 \frac{d^2y}{d^2x} = W_n + 1\,(l_n + 1 - x) \ldots\ldots\ldots (2a)$$

Integrating, and noting that $EI_n + 1 \frac{dy}{dx}$ from (2) must be equal to $El_{n+1} \frac{dy}{dx}$ from (2a) when x has the value l_n, we obtain: for

$$o \leqq x \leqq l_n$$

$$EI_n + 1 \frac{dy}{dx} = W_n + 1\left(l_n + 1 - \frac{x^2}{2}\right) W -_n \left(l_n x - \frac{x^2}{2}\right) \ldots (3)$$

and for
$$l_n \leqq x \leqq l_n + 1$$

$$EI_n + 1 \frac{dy}{dx} = W_n + 1 \left(l_n + 1 - \frac{x^2}{2}\right) - W_n \frac{l_n^{\,2}}{2} \ldots (3)$$

Integrating again, and noting the equality of $El_{n+1} y$ from (3) and (3a) for $x = l_n$, we obtain for

$$o \leqq x \leqq l_n$$

$$EI_n + 1y = W_n + 1\left(\frac{l_n + 1x^2}{2} - \frac{x^3}{6}\right) - W_n\left(\frac{l_n x^2}{2} - \frac{x^3}{6}\right) \ldots (4)$$

and for
$$l_n = x = l_n + 1$$

$$EI_n + 1y = W_n + 1\left(\frac{l_n + 1x^2}{2} - \frac{x^3}{6}\right) - W_n\left(\frac{l^2{}_n x}{2} - \frac{l^3{}_n}{6}\right) \text{ (4a)}$$

Putting $x = l_n$ in (4) and $x = l_{n+1}$ in (4a) we obtain:

$$EI_n + 1\delta_n = W_n + 1\left(\frac{l_n + 1l_n^{\,2}}{2} - \frac{l_n^{\,3}}{6}\right) - W_n \frac{l_n^{\,3}}{3} \ldots\ldots (5)$$

$$_n + 1\delta_n + 1 = W_n + 1 \frac{l^3{}_n + 1}{3} - W_n\left(\frac{l^2{}_n l_n + 1}{2} - \frac{l^3{}_n}{6}\right) \ldots (5a)$$

Now putting n for $n + l$ in (5a) there results:

$$EI_n\delta_n = W_n \frac{l^3{}_n}{3} - W_n - 1\left(\frac{l^2{}_n - 1\,l_n}{2} - \frac{l^3{}_n - 1}{6}\right) \ldots\ldots (6)$$

And equating the values of δ_n as given by (5) and (6) we obtain (we assume the material of all the leaves to be the same, so that the E's are equal):

$$6E\delta_n = \frac{W_n + 1(3l^2{}_n l_n + 1 - l^3{}_n) - 2W_n l_n^{\,3}}{I_n + 1}$$

$$= \frac{2W_n l_n^{\,3} - W_n - 1\;(3l_n^{\,2} - 1l_n - l^3{}_n - 1)}{I_n} \ldots (7)$$

If the material of the leaves be different, then equation (7) becomes:

$$6\delta_n = \frac{W_n+1\ (3l_n{}^2l_n+1-l_n{}^3)-2W_nl_n{}^3}{E_n+1\ I_n+1}$$

$$= \frac{2W_nl_n{}^3-W_n-1(3l_n{}^2-1l_n-1l_n{}^3-1)}{E_nI_n} \quad \ldots\ldots(7a)$$

Equation (7a) is only of academic interest, for clearly the material of all the leaves in any spring is always the same; still we wish to indicate the generalisation of the theory. The reader may find interest in working out a composite spring in which

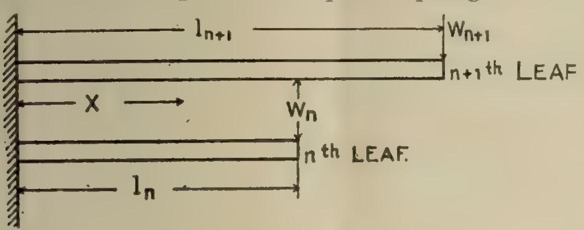


Fig. 7.

the leaves are composed of materials having various values of E.

Equation (7) is the most important and fundamental relation between the lengths of the leaves and their corresponding reactions or tip pressures, W. For any particular spring of given dimensions, the reactions may readily be determined in progressive order, starting with the bottom or short leaf.

For the short leaf we have $n=l$, and $l_0=o$, so that relation between the short leaf and the second one is:

$$\frac{W_2(3l^2{}_1l_2 - l_1{}^3) - 2W_1l_1{}^3}{I_2} \quad \frac{2W_1l_1{}^3}{I_1}$$

and since the l's are usually given, the W's are determined from this relation. Knowing the loads and the lengths, as well as the cross-sections, the stresses are then readily found.

Equation (7) explains the many difficulties and inconsistencies found when endeavouring to force the old theory into agreement with practice; it shows at once that the strength of a spring is not nearly in direct proportion to the number of plates. It interprets without any modification, the reason for the failure of the short leaf of any ungraded spring, and of nearly all the graded ones; it shows the reason why the endurance at a given deflection decreases with the increase in the number of leaves, and it fully explains many apparent inconsistencies which we have met with on the endurance testing machine, and the results of practice.

Having now shown the derivation of one of our fundamental formulæ, we propose to show its application to the study of particular cases. Not the least of its usefulness will be found in its application to the study of the exact character of the deflection experienced by each leaf of a spring. We shall show further that equation (7) explains fully all the difficulties indicated by the endurance tests mentioned previously, and also many others for which the old theory is unable to offer any rational explanation.

We may mention here that the fundamental reason for failure of the old theory is that it ignores the clamping of the leaves at the centre of a semi-elliptic spring, or at the end of a cantilever spring. The old theory assumes each plate can move vertically and independently at the point of encastrèment, and it is quite correct if such a condition holds; this condition never does hold in practice, and the effect of the clamping is sufficient to vitiate the old theory to such an extent as to render it useless from both the theoretical and practical points of view.

We will now apply our established equations to see what they may reveal; we will also test them to discover if they are capable of explaining the facts revealed by the endurance tests mentioned in the earlier portion of this paper.

As the simplest elementary case let us apply the fundamental equation (7) to a two-leaf spring. We will take the overhangs equal, so as to get an exact comparison with the results of the old theory as outlined above.

If the plates are of the same cross-section, the moments of inertia are equal, then the fundamental equation becomes:—

$$W_n+1(3l^2{}_nl_n + 1 - l^3{}_n) - 2W_nl_n{}^3$$

$$= 2W_nl_n{}^3 - W_n - 1(2l_n{}^2 - 1l_n - l_n{}^3 - 1)$$

or for the present case, where $n=1$ and $l_2=2l_1$, we have:—

$$W_2(3l^2{}_1l_2 - l_1{}^3) - 9W_1l_1{}^3 = 2W_1l_1{}^3 - W_0(3l^2{}_0l_1 - l_0{}^3)$$

and as $l_0=0$ (has no existence), the last term vanishes, and l_1 cancels, leaving:—

$$5W_2 - 2W_1 = 2W_1,$$

or

$$W_2 = \tfrac{4}{5}W_1$$

Here we see that the new theory indicates the reactions are not at all equal. To put it into words, our theory shows that for a unit load W to act on the point of the short leaf, the load applied to, or the pressure required on the end of the next longer leaf,

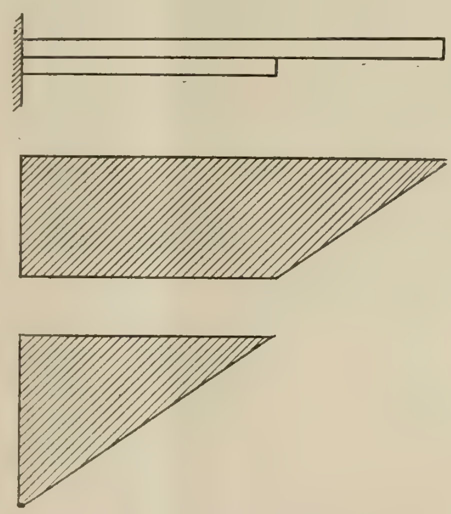


Fig. 8.

is only 4/5 of the unit load W_1; or, for unit load placed on the end of the second leaf (in the present case the master leaf), there is produced a reaction or pressure on the end equal to 5/4 times the unit load. This is a very different result from that given by the old theory, and shows that the actual stress in the short leaf is 25 per cent more than is accorded to it by the old theory.

The maximum bending moment on the short leaf is W_1l_1: that on the plate next above it is

$$W_2(l_2 \ \ l_1) = W_2(2l_1 - l_1) = W_2l_1 = \tfrac{4}{5}W_1l_1.$$

This calculation shows conclusively that the stress in the master leaf of a two-leaf spring, at its maximum value, can be only four-fifths of that in the short leaf. We see thus that the actual stress in the short leaf, according to our theory, is considerably the greater, which therefore accounts exactly for the results our experiments persisted in showing and which is so frequently observed in practice, namely, that the short leaf fails first.

Fig. 8 shows clearly, in graphic form, the stress at every section of both plates; it will be noticed that the stress in the short lamina increases from zero at the end to a maximum at the point of fixation, while at the same time the stress in the master leaf increases from zero at the end to a maximum, which maximum occurs directly over the end of the short leaf, and then gradually *decreases* towards the point of fixation. The maximum stress in the master leaf is thus only four-fifths of that in the short leaf, and the stress in the master leaf at the point of fixture is only three-fifths of that in the short leaf at the same place. It should be noticed, too, that the distribution of the stress is entirely different for the two leaves—a condition not even suspected heretofore.

(*To be continued.*)

COAL ECONOMY: FACTS OF INTEREST TO MILL ENGINEERS.

By Mr. W. M. Miles, of the Board of Trade.

(*Concluded from page 165.*)

It has already been pointed out how and why much heat is wasted in the form of unburnt ash; this is a loss which can be easily remedied, either by examining the ash or by making sure that it is ash before it is dumped. With regard to loss due to excess air, this is very difficult to find out when no draught gauges or gas testing apparatus is available. The following tabulated list shows how excess air reduces the amount of heat available for steam raising:—

Table Showing Loss Due to Excess Air.

Using Coal No. 2, exit gases 460 deg., Air 60 deg., B.TL.U. in Coal 12,500.

C.O.$_2$ per cent.	Volumes excess of Air.	Excess per lb. of C.O.$_2$.	Equivalent in lbs.	Total lbs. of air used.	Total units of heat lost.	Chimney loss.	Chimney Loss plus 5 per cent ash and radiation.	Heat available for boiler.
18·16	0·0	0	0	10·387	1692	13·55	18·55	81·45
18	1·0	·055	·0091	10·396	1693	13·55	18·55	81·45
17	7·0	·396	·7235	11·110	1761	14·09	19·09	80·91
16	13·5	·744	1·3593	11·746	1821	14·56	19·56	80·44
15	21	1·158	2·1157	12·503	1893	15·15	20·15	79·85
14	29·8	1·641	2·9981	13·385	1977	15·81	20·81	79·19
13	39·6	2·192	4·0048	14·392	2073	16·59	21·59	78·41
12	51·4	2·832	5·1840	15·571	2186	17·49	22·49	77·51
11	65	3·581	6·5424	16·929	2314	18·51	23·51	76·49
10	81·6	4·500	8·2215	18·608	2474	19·79	24·79	75·21
9	102	5·625	10·2768	20·664	2669	21·35	26·35	73·56
8	127	7·000	12·7890	23·176	2908	23·27	28·27	71·73
7	160	8·920	16·2968	26·684	3242	25·93	30·93	69·07
6	203	11·400	20·8278	31·215	3673	29·39	34·39	65·61
5	264	14·54	26·5649	36·952	4217	33·74	38·74	61·26
4	355	19·55	35·7178	46·105	5088	40·70	45·70	54·30
3	506	27·90	50·9733	61·360	6538	52·30	57·30	42·70

From 18 to 14 per cent CO. the loss by chimney gases increases by 2.2 per cent only, but from 14 per cent downwards, the loss due to low CO_2 and excess of air considerably increases until at 3 per cent (a figure which is very often obtained) the loss due to waste gases is over 52 per cent. There is no doubt that most of the loss in boiler working goes up the chimney, due to the fireman not realising the importance of his work. It is surprising to hear the answers one gets when questioning some firemen on combustion. They take it that coal—when dumped in front of their boiler—has to be burnt, which they do very uneconomically; some, of course, are better than others. One may be a particular offender in wasting coal by unburnt fuel in the ash; another, apparently giving good ash, spoils matters by keeping dampers always full open, and meeting the extra demands for steam by putting on more coal, whereas a good man will have the damper so regulated that with any load the loss going up the chimney will not be out of reason.

It should be good practice if firms using coal would have it analysed periodically, see how much air is required to burn it, then tabulate the meaning of excess air and low percentages of CO_2 as shown. All that is required is a reliable thermometer and an Orsat apparatus or an automatic gas testing machine. In any case, the expense is not very much, and the return can be anything conscientious workmen like to make it.

Low percentage of CO_2 is attributed to several causes, chief of them being as follows:—

No. 1.—Too much air, dampers open too wide. This makes fans, if used, do more work than is necessary, and wastes energy.

No. 2.—Bare parts in the firegrate where the air rushes through, leaving a shortage for the covered portion. Air will always pass more freely where there is least resistance, and it would rather pass through an open space than that covered by coal. A grate covered evenly with coal gives better fires, keeps out the aforementioned excess air, and naturally keeps an even and higher temperature throughout the boiler.

Where bare spaces in grates are caused through uneven firing, the remedy is not difficult, but sometimes these are caused on chain grates due to the

larger sizes of coal falling at the sides, while the small slack keeps in the centre; naturally there is a beter distribution of air to this larger size of coal at the sides. Not only that, in burning, a good heat is given out, and the temperature is so high that the bricks on the furnace wall, together with small siliceous matter from the ash in the coal, forms a slag which runs across the grate till it meets the cooler portion or that with the smaller coal. Here it gets hard and forms a dam which bares the rest of the grate as it comes along. These dams of clinker cause a lot of trouble and ought to be removed by slicing when necessary.

No. 3.—Another source of loss is due to too much time being spent in carrying out dumping, and, consequently, cold air rushes through the boiler and leaves with useful heat.

Doors should not be opened too often, and large doors should not be opened when small ones are provided for that purpose.

No. 4.—Besides excess air admitted by the damper, a fair amount can get through cracks in boiler walls and casings, badly-fitting doors, etc. In boilers fitted with hoppers, such as chain grates, the coal sometimes sticks or runs out, and if not seen, cold air rushes through the portion which could otherwise have been sealed by the coal entering.

Smoke tests made periodically will show most of the places where cold air enters the boiler, and these, on being found, should be made tight with magnesite, asbestos, or other suitable plaster.

It does not seem to be beyond anyone to stop most, if not all, of the aforesaid sources of loss, and if everyone would do a little towards this end, they will, in the future, be doing a *National Service.*

(Concluded.)

IRONCLAD AIR-BREAK CIRCUIT BREAKERS.

By J. F. Foley.

For industrial undertakings, wherever air-break gear is permissible for various voltages up to 650, the air-break switch and fuse, or a circuit breaker fixed in a cast-iron box, is often installed. A circuit breaker fitted with an overload and no-volt release is supplied in preference to the switch and fuse when the circuit is frequently broken, and where a finer setting is required for dealing with an overload, or where the voltage drops below a predetermined limit. A switch and fuse constantly switched " in " or " out " on load will damage the contacts very quickly, thus shortening the life of the switch. Secondly, regarding heavy overloads, labour and loss of time, due to stoppage for re-wiring fuses, are also to be considered, unless a range of spare fuses is kept close at hand.

The sizes of the modern ironclad breakers are usually designed for currents ranging from 25 to 200 amperes, suitable for working on voltages up to 650 and fitted with loose handle and mechanism.

Continuous-current circuits are more difficult to interrupt than alternating current on inductive load, and gear which would be quite adequate on A.C. will not necessarily do for continuous current. The inductive pressure rises are much greater and the arcing more vicious.

It is advisable to fit a magnetic blowout and suitable arc shields on all these breakers which are fitted in enclosed boxes. Although these remarks do not deal with any special make of breaker, they may be found useful to the draughtsman or electrician who is involved with any trouble which may arise.

Loose Handle.

Most breakers are fitted with the loose-handle mechanism and quick-break action, which comes into play both when the breaker is automatically tripped or when released by hand. The function of the loose, or free handle, as commonly termed, is such that the breaker cannot be held closed on overload or fault conditions.

Overload Coils.

For very small currents an insulated copper wire-wound coil is used, and for larger sizes the coils are of rectangular copper, wound edgewise. The standard calibration for tripping on overload usually ranges from 50 per cent to 250 per cent of normal full load rating. To prevent the breaker frequently tripping whilst starting up a D.C. motor against a heavy starting torque it is necessary to fit a time-limit device to the plunger of the overload coil. The excessive current taken by the motor may continue only for a period of half a minute, and in this time there is little fear of it burning out.

This delay action on the breaker is also advantageous whilst the motor is running on a momentary overload, so long as the time element is not exceeded.

No-volt Coil.

It is essential for the manufacturer to know whether the breaker is required for an A.C. or C.C. circuit. In the former case, the normal working voltage and periodicity is required, and, in the latter, the normal working voltage for the design of the coil. On continuous current supplies it is advisable to design the no-volt coil so that it may be connected *directly* across the mains.

The best practice, however, would be to fix on a standard size of coil, say, up to 100 volts for direct connected, and to insert a resistance in series with the coil, for the various voltages above this. Under normal working pressure, the plunger is held up, and when the voltage drops below a certain limit, or when the pressure is removed, the plunger drops and automatically trips the breaker.

A simple device is fitted for A.C. circuits, in the form of a brass disc or band, which is inserted in the top laminated plunger, thus eliminating chattering due to the pulsating flux.

The most frequent trouble with an A.C. no-volt coil is the burning out. The working temperature is fairly high, and when the plunger binds, for any reason, the current passing through the coil may be several times the normal. The plunger should be removed from time to time and cleaned with thin oil, so as to ensure it working smoothly.

Toggles or Other Mechanism.

In designing mechanism it should be of the simplest form, avoiding unnecessary bent links, springs, pins, and other small parts, wherever possible. The usual trouble experienced is due to defective material, or to legitimate wear owing to

the frequent operation. In the latter case, great care should be exercised in re-adjusting these important features by a capable person.

Cases have been reported where unskilled men have tampered with the triggers, so much as to render the release of the breaker impossible.

Contact Brush and Arc Tips.

The brush consists of several layers, or copper laminations, varying in number with the current capacity. Each lamina must be free to move and bed with sufficient pressure on the contact block.

In breaking circuit, the brush is separated first, and then the current is shunted through the arcing tips, which are usually renewable copper segments or carbon blocks.

A thin layer of oxide may cause heating, which may eventually develop into a blob of metal between the brush laminations should arcing take place. It is advisable to periodically examine the brush and contact blocks, and give them an occasional rub over with very fine emery paper. Contact should be tested by taking the mili-volt drop on full load continuous current.

Insulation.

This is usually of mica, micanite, or micarta, and breakdown may be due to dirt, damp, or excessive pressure rises on breaking circuit. The insulation test takes place at the factory when the breaker is completed, prior to shipment.

A flash test of 2,000 volts A.C. is the general practice for low and medium voltages. However, a frequent inspection will obviate a deal of trouble which may arise whilst the breaker is under working conditions.

Interlocking Device.

An interlock is necessary so as to prevent opening the door with the breaker "*in*;" secondly, to prevent the operator from closing the breaker with the door open.

Flame-Proof Gear.

Where coal, flour dust, cotton fluff, or other inflammable material is in the vicinity, flame-proof gear is often used. Although the internal fittings may be the same as for standard breakers, the cover and boxes are of special design. A long flange, usually about 1½ in. long, is cast on the cover and box so as to leave a small air gap between top and bottom flange.

The function is such that in breaking on load, any flames or hot gases which may escape from the box will be cooled down before reaching the outside air.

Oil switches are sometimes used on C.C. circuits. though not to the same advantage as on A.C. supplies. The air-circuit breaker dealt with in this article is designed to break several times its normal current, but is only for commercial purposes, and not for a circuit in an installation close to the power station.

For breaking large A.C. power circuits, the oil breaker is the ideal apparatus under all conditions, and has in some cases to break many times its maximum normal capacity in a large power station.

A full detail on this important subject of oil breakers, however, is beyond the scope of this article, and should be dealt with separately.

UNDERCUTTING IN GENERATED INVOLUTE SPUR PINIONS.

ITS CAUSES AND PREVENTION.

By G. H. Middleton.

(*Concluded from page 171.*)

Below the limits calculated from the formula 1 and 1a, interference will be present, and undercutting noticed. Since the interference line LL determines the point of undercut, we can completely prevent this occurring by shortening the rack addendum by a distance x—

$$x = a - \text{MP (from Fig. 1.)}$$
$$= a - \text{R} \sin {}^2\beta$$
$$= a - \frac{\text{N}}{2\,\text{D P}} \sin {}^2\beta \qquad (5)$$

In terms of C P

$$x = a - \frac{\text{N} \times \text{C P}}{2\,\pi} \sin^2\beta \qquad (5\text{A})$$

For the B. and S. standard shape, this becomes a very simple formula:—

$$x = \frac{1}{\text{D P}} - \frac{\text{N}}{2\,\text{D P}}\ \frac{1}{16}$$
$$= \frac{1}{\text{D P}}\left\{1 - \frac{\text{N}}{32}\right\} = \left\{\frac{32 - \text{N}}{32}\right\} a \qquad (6)$$

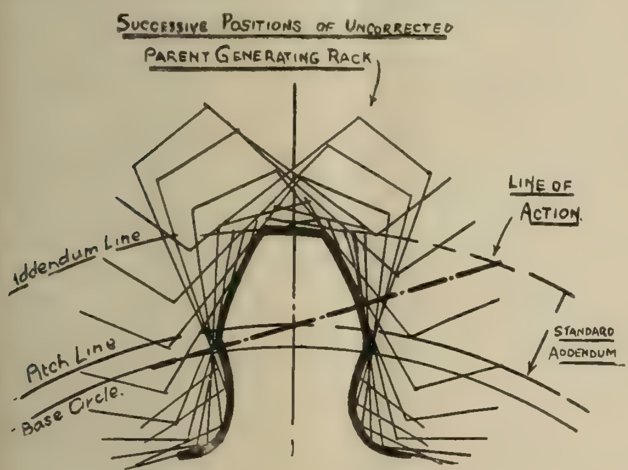
This means that the rack addendum should be shortened by an amount equal to $\frac{32 - \text{N}}{32}$ times the addendum for the pitch chosen for the Brown and Sharpe system, and an amount similarly calculated for other systems.

Shortening the rack addendum means a shortening of possible contact, and a varying tooth depth for all corrected racks. To prevent this variation, the pinion addendum is increased by the same amount x, and its dedendum decreased, while the rack dedendum is increased. Hence the depth is the same, while contact and strength are much improved. Again, the pinion approach contact never can extend below the base circle (less than that, if undercutting takes place), and by shortening the addendum of the rack or mating gear there is a tendency to equalise the wear on each, while the longer addendum of the pinion is more nearly equal in wearing surface to the rack or gear dedendum. (Note.—Addendum and dedendum are here used to mean the face and flank of the tooth respectively.) This, of course, makes for longer life and greater efficiency of the gears.

That this is possible depends on the fact that the pinion-working surface is higher up the involute curve than standard, while the gear surface is a lower part of its involute. This is due to the flexibility of the involute, which works at variable centres with mathematical correctness. An analogy to the involute may be seen in considering a crossed belt on two pulleys (the base circles). Any point on the straight portion of the belt (the line of contact or line of action) will describe involutes relative to both circles, and will continue to do so even if separated or closed in to other centres.

We have shown that for the Brown and Sharpe system—which is most used in this country—32

teeth is the limit at which interference occurs with an uncorrected rack. Actually, the corners are rounded, and the limit thus reduced. Pinions are also generally in mesh with gears, and the interference with a gear is less than with the rack, owing to the latter having its faces more rounded. Hence, the suggested enlargement commences with 25 teeth (20 teeth for other systems with larger pressure angles and lower interference limits), and the nominal pitch diameter, or the diameter one addendum below the outside, corrected, diameter is calculated from the following formula—an empirical one, which can be proved to give approximately four-fifths of the theoretical enlargement necessary.



Undercutting in Generated Involute Spur Pinions —Fig. 2.

If Q is the predetermined number of teeth at which enlargement is to commence, then—

$$\text{Nominal P C diameter} = \frac{\frac{Q-1}{Q} \times N - 1}{D\,P} \qquad (7)$$

Hence for a predetermined limit of 25

$$\text{nominal P C diameter} = \frac{\cdot 96\,N + 1}{D\,P} \qquad (7\text{A})$$

If 20 teeth is used, which gives more than the necessary enlargement for the modern stub tooth, 20 deg. pressure angle, then—

$$\text{Nominal P C diameter} = \frac{\cdot 95\,N + 1}{D\,P} \qquad (7\text{B})$$

It is worthy of note that Messrs. Brown and Sharpe, and English manufacturers, advocate an enlargement, similar to the above for worm wheels, but there the full possible amount is taken (*i.e.*, from 30 teeth). The formula given by Brown and Sharpe in their "Practical Treatise on Gearing" is as follows:—

$$\text{Throat diameter} = \cdot 9375 \times \frac{N}{P} + 4 \times \text{add}$$

$$= \frac{\cdot 9375\,N + 4}{D\,P}$$

This is, of course, for standard proportions, and 14½ deg. pressure angle, and completely prevents any undercutting.

I say *nominal* because the actual running pitch circle does not vary, and the pitch point still intersects the line of centres in the same ratio as if uncorrected. If it did not there would be a change in velocity ratio, which we know is not the case. Then again, there would be two gears of different pressure angles in mesh together if the pitch circles actually moved, and this would not fulfil the Law of Tooth Contact; and it may also be mentioned that the two gears cut with the same hob would only be truly conjugate if running on the original pitch lines. I trust, therefore, that this will dispel any erroneous impression that the pitch circles are actually altered.

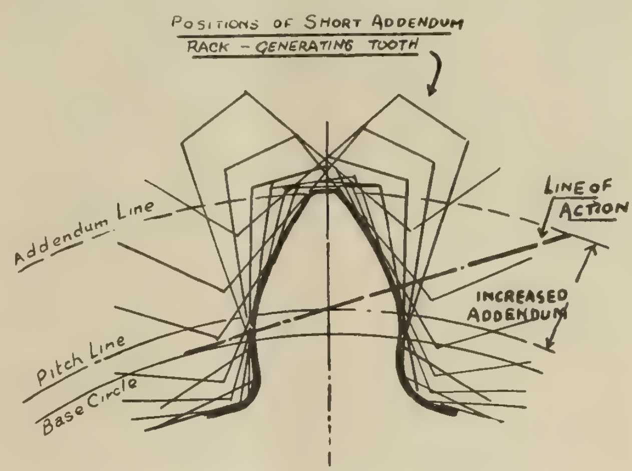
As a gear designer, I always make a practice that wherever possible the pinion shall be enlarged and the wheel blank decreased to keep the centres specified, as it has been found that better running and longer life result from the correction.

I hope to be able at some future time to discuss the actual contact lengths and numbers of teeth in contact, both under the standard and under the corrected conditions, and this will amplify the remarks here made.

Figs. 2 and 3 will serve to show the strengthening and other effects on the pinion so treated, Fig. 2 being the standard shape, uncorrected, and Fig. 3 the corrected shape using formula $\frac{\cdot 96\,N + 1}{D\,P}$.

Summarising briefly the points of the article, we have:—

(1). Interference is a phenomenon which occurs when the possible approach contact of the one odontoid is less than the possible contact of the mating odontoid, causing the "undercut" on small pinions.



Undercutting in Generated Involute Spur Pinions —Fig. 3.

(2). Interference of straight-sided rack with pinion commences at the limits given by Formulæ 1, 1A, and 2.

(3). Interference in generating with unrounded tools commences at limits given by Formulæ 3, 3A, and 4.

(4). Gears should be enlarged by Formulæ 7, 7A, and 8, if below the limit, the various formulæ depending on pressure angle and height of teeth.

(5). The pinions so cut show a marked improvement on the standard, undercut, and uncorrected pinions generally met with; a fact which the figures will emphasise.

(Concluded.)

ECONOMIES IN THE GENERATION AND USE OF STEAM.

By Sidney F. Walker, R.N., M.I.E.E., M.I.M.E.

(Continued from page 150.)

Another source of loss in the condenser is leakage between the circulating water and the condensate. This may become a serious trouble, because it may mean that a certain quantity of water carrying salts of calcium, and magnesium, in solution, is carried over into the boiler, and there will be the probability of their depositing on the water side of the heating surfaces there. An apparatus has been introduced within the last few years enabling this to be tested automatically. A small sample of the feed water is passed periodically into the testing apparatus, which consists of a vessel into which two electrodes are sealed, the electrodes being immersed in the sample. A small current of electricity is kept flowing through the sample of feed water, from one electrode to the other.

It will be remembered that the electrical resistance of pure water is very high indeed; the addition of any salt carried in solution lowers its resistance in a certain definite ratio. An indicator forms part of the apparatus, which consists of a galvanometer whose dial is graduated in percentages of the salts that are likely to be met with. It is quite practicable to add the usual recording pencil and sheet to the apparatus, and so to provide a record of any leakage of the cooling water that may have taken place during the whole running time. All leaks have one thing in common; they all tend to increase, because the mere passage of a gas or a liquid through a crack or a small hole, such as would give rise to leakage in a condenser, tends to wear the crack or the hole larger. The use of this apparatus should be of great assistance in keeping the engineer master of the condensing plant, and indirectly in reducing the cost of generating steam.

There is another question in connection with the tubes of surface condensers, namely, the best sizes. The internal diameter is the most important dimension, and that is usually ¾ in.; but in certain cases it has been found advantageous to increase the size to as much as 1¼ in. On the other hand, from experiments made by Prof. Weighton, at the Armstrong College, Newcastle-on-Tyne, some years ago, it was shown that better results were obtained by reducing the diameter of the tubes to ⅝ in. and a still further economy was obtained by partially filling the condenser tubes with wooden cores of triangular section. The points that have to be considered are, if the cooling water contains much matter, either in solution or carried mechanically, that will be deposited on the inside of the tubes, the bores of the tubes will be very quickly reduced. A case is reported from Yorkshire, where very dirty condensing water containing trade refuse, consisting of oily and woolly material, and at certain times of the year, dead leaves and mud, had to be employed. The silting up of the tubes was accomplished so rapidly that the condensers had to be cleaned almost weekly at certain times of the year. In this case, by increasing their diameter to 1¼ in., and making the ends with special fittings designed to catch the woolly material, the difficulty was overcome.

On the other side of the question, it will be remembered that water is a very bad conductor of heat, and, consequently, it is only the skin of the water in contact with the metal of the tubes that really does any useful work, and absorbs heat from the steam flowing over the outside of the tube. It will be evident that, by reducing the diameter of the tubes, the area of the wasted core of the water that does no useful work is lessened. In addition to this, it has been found by practical experience, confirming careful experiments by a very eminent firm of condenser manufacturers, that an increased rate of flow of the circulating water through the tubes tends to keep them clean. There is not much chance for salts or mechanically-carried matter to be deposited when the flow is at a high velocity. It will be remembered that the power required by the circulating water depends upon (*a*) the lift against gravity; (*b*) the friction of the water on the walls of the tube. The friction varies directly with the extent of surface of the tubes, and as the square of the velocity at which the water flows through them. It may easily happen, therefore, that the power required is the same with smaller tubes, in which the water is flowing at a higher velocity; as with larger tubes in which it flows at a lower velocity; while the transference of heat per square foot of surface of tube is higher with the smaller tubes, and the quantity of water used is less. Another instrument that should be of assistance in enabling the engineer to keep in touch with the working of his condenser, is a waterflow meter in the circuit of the circulating water.

Modern Forms of Air Pumps.

As mentioned in a previous article, before the advent of the steam turbine, and the demand for higher vacua, the Edwards' bucket air pump was *facile princeps*, because it was able to deal with almost any conditions, and to produce the vacuum that was satisfactory in those days; mainly because the condensate was cooled down, its lower temperature enabling it to absorb more air than those apparatus in which the condensate was not cooled; and, therefore, a larger proportion of air inside the condenser was carried off. The first attempt to increase the vacuum was made by Sir Charles Parsons, by the aid of the apparatus he termed a vacuum augmenter. In that apparatus, it will be remembered, a jet of steam was employed to draw off the air and uncondensible gases through an auxiliary condenser, the whole condensate being delivered to the air pump. This idea has been taken up by other inventors; and in addition, the principle of the ejector condenser has been applied to deal with the problem of drawing off the air separately. Inventors have worked on two lines: one group, headed by a very able French scientist and engineer, Professor Maurice Le Blanc, has developed what has been termed a rotary pump, in which centrifugal force is employed to break up a stream of water into small sections or slices, each section being designed to entrain a small quantity of air. It is claimed by the inventors of the different forms of rotary pumps that a new principle is made use of. On the other hand, the inventors of other apparatus claim that the rotary pump, as employed for entraining air, is merely a development of the well-known ejector condenser. In this apparatus,

a stream of water is forced through a nozzle under a certain pressure, and is made to suck the steam from the exhaust of the engine or turbine by the well-known injector action, the steam being condensed by contact with the water and carried off with it to the drains, the cooling-tower pond, or wherever the supply of water is obtained. There is a multi-jet ejector condenser on the market that has been introduced, the writer believes, since the advent of the Le Blanc rotary pump, which, it is claimed, is more economical and simpler than the rotary, or any of the other types on the market. The ejector condenser has been rather a favourite in many districts, particularly in Lancashire, and for comparatively small power plants, on account of its great simplicity. One serious objection to it, from the point of view of economy, is that the latent heat of the steam is all wasted, and no portion of it is available to reduce the cost in coal for generating steam in the boiler. It is very doubtful, also, whether it is economical on light loads, the proportion of power that has to be expended in pumping the cooling water being almost constant. There are some queer tales told also about its behaviour on heavy loads. The chief engineer of the electricity generating station of one of the group of towns in the neighbourhood of Manchester told the writer that one day during time of peak load the boiler pressure and the electrical pressure began to drop. The shift engineer ran up to him in great anxiety, reporting the matter. "Take the condenser off," was his order, and the station as a whole stood up to its load. The condenser was of the ejector type. The writer did not hear what was the cause of the trouble, but evidently the steam required for pumping the condensing water more than compensated for the saving the condenser produced, so that the plant as a whole was a little better off without the condenser.

(To be continued.)

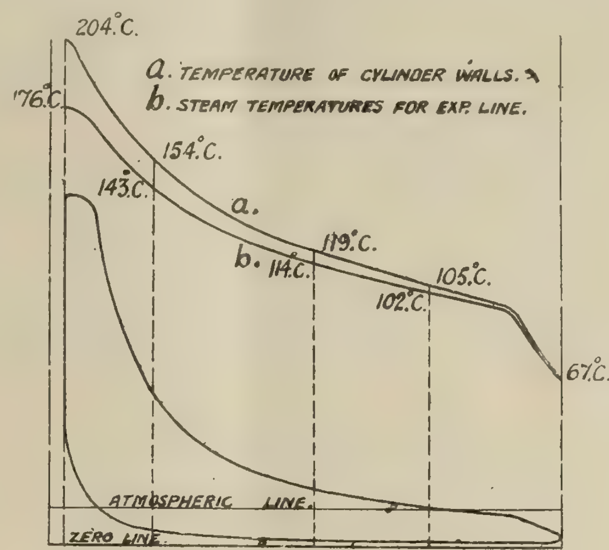
THE UNAFLOW STEAM ENGINE.

By D. H. Yates.

(Continued from page 193.)

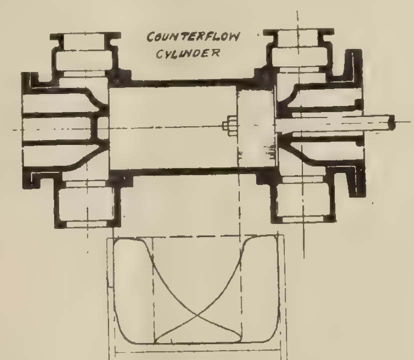
Referring again to Fig. 10, it will be seen that the ends of the cylinder barrel are in this case steam jacketed, the jackets being connected to the steam valve box by means of a pipe and valve so that the steam admitted to these jackets is under control, and the jackets may be cut out altogether if desired. The excellent thermal properties of the Unaflow engine are indicated in Fig. 12, which gives actual temperature readings taken from the walls of a cylinder with jacketed covers and non-jacketed barrel, the experiments being conducted by Professor Stumpf. These temperatures are indicated by the upper curve *a*, which lies above the temperature curve *b* of the steam expansion line of the indicator diagram.

If we now refer to Fig. 14, we find a diagrammatic sketch of a Unaflow cylinder and piston, with indicator diagrams below. The latter show how the working portions of each end of the cylinder are separated from each other by a distance equal to 9/10ths of the stroke, the diagrams only overlapping at the exhaust. This is equivalent to having two single-acting cylinders placed end-to-end, so avoiding the thermal mix-up which takes place in a counterflow engine, as indicated by Fig. 13. This figure shows the indicator diagrams overlapping each other for a considerable distance, the toe of each almost running up to, and in the case of a shallow piston, quite up to the steam admission space of the other.



Unaflow Steam Engine.—Fig. 12.

Fig. 14 also shows the probable condition of the steam in a Unaflow cylinder when exhausting. The steam has first entered the cylinder without condensation, any tendency in this direction due to the comparatively cool end of the piston being discounted by the superheat in the compressed steam. The cause of the superheat of the termination of compression is easily explained. The steam, during expansion, falls in temperature as it follows the piston, and probably there is also a slight amount of condensation nearer the end of the stroke, the wettest portion of the steam always being next to the piston. Immediately the exhaust ports open, the wet particles are swept out through the exhaust ports with a scavenging action, leaving only dry steam in the cylinder when compression commences. That portion of the steam nearest the cover having been receiving heat from the jackets during expansion is now in a superheated state, and will continue to receive heat from the jackets for a portion of the compression. This heat, added to that created by



Unaflow Steam Engine.—Fig. 13.

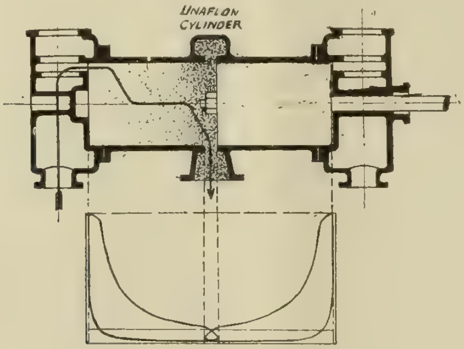
the act of compression, results in the finally compressed steam being in a highly superheated state, even if the live steam is saturated. Briefly stated, then, the cycle of operations in a Unaflow cylinder is as follows:—

1. *Steam Admission.* Cut-off varying according to pressure, no heat transference from jacket.

2. *Expansion* down to 90 per cent of the stroke with transference of heat from the jackets to the layers of steam next to the inlet end, whilst the wettest steam follows the piston without deposit of moisture on the barrel.

3. *Release* at 90 per cent of stroke with the wet steam passed off from the cylinder with a scavenging action.

4. *Compression* at 10 per cent of the exhaust stroke and continuing for the remaining 90 per cent of the stroke. The dry heated steam is trapped in the cylinder and compressed up to the inlet end where the clearance is small. Heat is transmitted from the jacket to the steam during the first part of the



UNAFLOW STEAM ENGINE.—FIG. 14.

compression, and the steam is in a superheated condition at the termination of compression. Waterhammer is therefore impossible.

The cylinder covers are always jacketed, and it is advisable to jacket the steam ends of the barrel when using saturated steam, or saturated steam with a low superheat, but the value of jacketing the barrel is less apparent with the introduction of highly superheated steam. If, however, the barrel is provided with a jacket which can be shut off if desired, conditions can be presented which should reasonably satisfy all tastes.

The front valve box is secured to the frame, which is of the trunk type, and the back valve box is overhung from the cylinder barrel. The valve boxes and steam jackets are covered with non-conducting composition, but not the exhaust belt, so ensuring that the steam ends of the cylinder are kept hot and the exhaust portion cool. Every precaution is also taken in designing the cylinder to prevent the loss of heat through conduction and radiation, and an ample and efficient drainage system is provided to deal with any condensation which might accrue due to warming up, etc. The cylinder is also provided with the usual indicator fittings, one at each end of the cylinder.

Before closing this section of the article, it would perhaps be of advantage to indicate broadly the rules which a designer should adopt when dealing with a steam-engine cylinder, in order to obtain economical results. These are:—

1. Clearance volume to be kept as small as possible.
2. Clearance surface to be kept as small as possible.
3. Clearance surface to be subjected to as constant a temperature as possible. This can only be done satisfactorily by the adoption of the Unaflow system.
4. The compression should be timed so that the clearance losses are a minimum.

Space will not allow for a further explanation of Rule 4, given above, but the author recommends this as being a favourable subject for study to anyone interested in steam engine design.

(To be continued.)

FOUNDATIONS.

By W. H. LATHAM.

(Continued from page 195.)

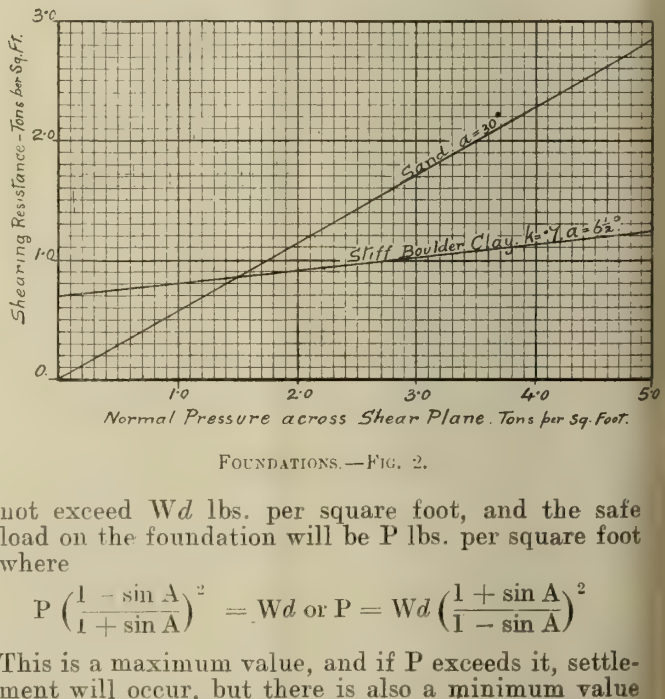
AT the edge of a foundation we have a double change of pressure, the vertical pressure Pv, under the base, is balanced by a horizontal pressure

$$Ph = Pv \left(\frac{1 - \sin A}{1 + \sin A}\right)$$

and this in turn gives rise to an upward pressure outside the base $Pv2$,

$$Ph \left(\frac{1 - \sin A}{1 + \sin A}\right) = Pv_1 \left(\frac{1 - \sin A}{1 + s\,n\,A}\right)^2$$

If the earth weighs W lbs. per cubic foot, and foundation is d ft. in depth, the pressure $Pv2$ must



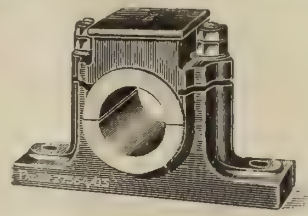
FOUNDATIONS.—FIG. 2.

not exceed Wd lbs. per square foot, and the safe load on the foundation will be P lbs. per square foot where

$$P \left(\frac{1 - \sin A}{1 + \sin A}\right)^2 = Wd \text{ or } P = Wd \left(\frac{1 + \sin A}{1 - \sin A}\right)^2$$

This is a maximum value, and if P exceeds it, settlement will occur, but there is also a minimum value for P. The external earth pressure Wd must be supported. It will cause a vertical upward pressure under the foundation

$$= Wd \left(\frac{1 - \sin A}{1 + \sin A}\right)^2$$



Weights of Lengths of Rolled Steel Sections.

Beam 4 in. × $1\frac{3}{4}$ in. × 7 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	Ft.
0	..	0 2 14	1 1 0	1 3 14	2 2 0	3 0 14	3 3 0	4 1 14	5 0 0	5 2 14	0
1	0 0 7	0 2 21	1 1 7	1 3 21	2 2 7	3 0 21	3 3 7	4 1 21	5 0 7	5 2 21	1
2	0 0 14	0 3 0	1 1 14	2 0 0	2 2 14	3 1 0	3 3 14	4 2 0	5 0 14	5 3 0	2
3	0 0 21	0 3 7	1 1 21	2 0 7	2 2 21	3 1 7	3 3 21	4 2 7	5 0 21	5 3 7	3
4	0 1 0	0 3 14	1 2 0	2 0 14	2 3 0	3 1 14	4 0 0	4 2 14	5 1 0	5 3 14	4
5	0 1 7	0 3 21	1 2 7	2 0 21	2 3 7	3 1 21	4 0 7	4 2 21	5 1 7	5 3 21	5
6	0 1 14	1 0 0	1 2 14	2 1 0	2 3 14	3 2 0	4 0 14	4 3 0	5 1 14	6 0 0	6
7	0 1 21	1 0 7	1 2 21	2 1 7	2 3 21	3 2 7	4 0 21	4 3 7	5 1 21	6 0 7	7
8	0 2 0	1 0 14	1 3 0	2 1 14	3 0 0	3 2 14	4 1 0	4 3 14	5 2 0	6 0 14	8
9	0 2 7	1 0 21	1 3 7	2 1 21	3 0 7	3 2 21	4 1 7	4 3 21	5 2 7	6 0 21	9

Weight of Beam, advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight.	lbs. 0·58	lbs. 1·16	lbs. 1·75	lbs. 2·33	lbs. 2·92	lbs. 3·50	lbs. 4·08	lbs. 4·67	lbs. 5·25	lbs. 5·83	lbs. 6·42	lbs. 7·0	Weight.

Weights of Lengths of Rolled Steel Sections.

Beam 4 in. × $1\frac{3}{4}$ in. × 7 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	6 1 0	12 2 0	0 18 3 0	1 5 0 0	1 11 1 0	1 17 2 0	2 3 3 0	2 10 0 0	2 16 1 0	0
10	0 2 14	6 3 14	13 0 14	0 19 1 14	1 5 2 14	1 11 3 14	1 18 0 14	2 4 1 14	2 10 2 14	2 16 3 14	10
20	1 1 0	7 2 0	13 3 0	1 0 0 0	1 6 1 0	1 12 2 0	1 18 3 0	2 5 0 0	2 11 1 0	2 17 2 0	20
30	1 3 14	8 0 14	14 1 14	1 0 2 14	1 6 3 14	1 13 0 14	1 19 1 14	2 5 2 14	2 11 3 14	2 18 0 14	30
40	2 2 0	8 3 0	15 0 0	1 1 1 0	1 7 2 0	1 13 3 0	2 0 0 0	2 6 1 0	2 12 2 0	2 18 3 0	40
50	3 0 14	9 1 14	15 2 14	1 1 3 14	1 8 0 14	1 14 1 14	2 0 2 14	2 6 3 14	2 13 0 14	2 19 1 14	50
60	3 3 0	10 0 0	16 1 0	1 2 2 0	1 8 3 0	1 15 0 0	2 1 1 0	2 7 2 0	2 13 3 0	3 0 0 0	60
70	4 1 14	10 2 14	16 3 14	1 3 0 14	1 9 1 14	1 15 2 14	2 1 3 14	2 8 0 14	2 14 1 14	3 0 2 14	70
80	5 0 0	11 1 0	17 2 0	1 3 3 0	1 10 0 0	1 16 1 0	2 2 2 0	2 8 3 0	2 15 0 0	3 1 1 0	80
90	5 2 14	11 3 14	18 0 14	1 4 1 14	1 10 2 14	1 16 3 14	2 3 0 14	2 9 1 14	2 15 2 14	3 1 3 14	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lbs. 3 2 2 0	t. c. q. lbs. 6 5 0 0	t. c. q. lbs. 9 7 2 0	t. c. q. lbs. 12 10 0 0	t. c. q. lbs. 15 12 2 0	t. c. q. lbs. 18 15 0 0	t. c. q. lbs. 21 17 2 0	t. c. q. lbs. 25 0 0 0	t. c. q. lbs. 28 2 2 0	t. c. q. lbs. 31 5 0 0	Weight

Compiled and Arranged by T. E Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam $3\frac{1}{2}$ in. × $1\frac{1}{2}$ in. × $5\frac{1}{2}$ lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	Ft.
0	0 0 0	0 1 27·0	0 3 26·0	1 1 25·0	1 3 24·0	2 1 23·0	2 3 22·0	3 1 21·0	3 3 20·0	4 1 19·0	0
1	0 0 5·5	0 2 4·5	1 0 3·5	1 2 25·0	2 0 1·5	2 2 0·5	2 3 27·5	3 1 26·5	3 3 25·5	4 1 24·5	1
2	0 0 11·0	0 2 10·0	1 0 9·0	1 2 8·0	2 0 7·0	2 2 6·0	3 0 5·0	3 2 4·0	4 0 3·0	4 2 2·0	2
3	0 0 16·5	0 2 15·5	1 0 14·5	1 2 13·5	2 0 12·5	2 2 11·5	3 0 10·5	3 2 9·5	4 0 8·5	4 2 75·0	3
4	0 0 22·0	0 2 21·0	1 0 20·0	1 2 19·0	2 0 18·0	2 2 17·0	3 0 16·0	3 2 15·0	4 0 14·0	4 2 13·0	4
5	0 0 27·5	0 2 26·5	1 0 25·5	1 2 24·5	2 0 23·5	2 2 22·5	3 0 21·5	3 2 20·5	4 0 19·5	4 2 18·5	5
6	0 1 5·0	0 3 4·0	1 1 3·0	1 3 2·0	2 1 1·0	2 3 0·0	3 0 27·0	3 2 26·0	4 0 25·0	4 2 24·0	6
7	0 1 10·5	0 3 9·5	1 1 8·5	1 3 7·5	2 1 6·5	2 3 5·5	3 1 4·5	3 3 3·5	4 1 2·5	4 3 1·5	7
8	0 1 16·0	0 3 15·0	1 1 14·0	1 3 13·0	2 1 12·0	2 3 11·0	3 1 10·0	3 3 9·0	4 1 8·0	4 3 7·0	8
9	0 1 21·5	0 3 20·5	1 1 19·5	1 3 18·5	2 1 17·5	2 3 16·5	3 1 15·5	3 3 14·5	4 1 13·5	4 3 12·5	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight
	0 ·45	0 ·91	0 1·37	0 1·83	0 2·29	0 2·75	0 3·20	0 3·66	0 4·12	0 4·58	0 5·04	0 5·5	

Weights of Lengths of Rolled Steel Sections.

Beam $3\frac{1}{2}$ in. × $1\frac{1}{2}$ in. × $5\frac{1}{2}$ lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 3 18	9 3 8	14 2 26	0 19 2 16	1 4 2 6	1 9 1 24	1 14 1 14	1 19 1 4	2 4 0 22	0
10	0 1 27	5 1 17	10 1 7	15 0 25	1 0 0 15	1 5 0 5	1 9 3 23	1 14 3 13	1 19 3 3	2 4 2 21	10
20	0 3 26	5 3 16	10 3 6	15 2 24	1 0 2 14	1 5 2 4	1 10 1 22	1 15 1 12	2 0 1 2	2 5 0 20	20
30	1 1 25	6 1 15	11 1 5	16 0 23	1 1 0 13	1 6 0 3	1 10 3 21	1 15 3 11	2 0 3 1	2 5 2 19	30
40	1 3 24	8 3 14	11 3 4	16 2 22	1 1 2 12	1 6 2 2	1 11 1 20	1 16 1 10	2 1 1 0	2 6 0 18	40
50	2 1 23	7 1 13	12 1 3	17 0 21	1 2 0 11	1 7 0 1	1 11 3 19	1 16 3 9	2 1 2 27	2 6 2 17	50
60	2 3 22	7 3 12	12 3 2	17 2 20	1 2 2 10	1 7 2 0	1 12 1 18	1 17 1 8	2 2 0 26	2 7 0 16	60
70	3 1 21	8 1 11	13 1 1	18 0 19	1 3 0 9	1 2 3 27	1 12 3 17	1 17 3 7	2 2 2 25	2 7 2 15	70
80	3 3 20	8 3 10	13 3 0	18 2 18	1 3 2 8	1 8 1 26	1 13 1 16	1 18 1 6	2 3 0 24	2 8 0 14	80
90	4 1 19	9 1 9	14 0 27	19 0 17	1 4 0 7	1 9 3 25	1 13 3 15	1 18 3 5	2 3 2 23	2 8 2 13	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	Weight
	2 9 0 12	4 18 0 24	7 7 1 8	9 16 1 20	12 5 2 4	14 14 2 16	17 3 3 0	19 12 3 12	22 1 3 24	24 11 0 8	

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

ENGINEERING APPOINTMENTS OPEN.

PERSONAL NOTES.

Mr. W. E. Crawley, who has been connected with Ferranti Ltd. for 27 years, has been appointed their sales representative for meters and instruments in the South of England.

Rownson, Drew and Clydesdale Ltd., engineers and metal merchants, have opened a branch at 16, Donegall Square South, Belfast.

The Edina Manufacturing Co., manufacturers of pumps and petrol motors, of 19, Broad Wynd, Leith, have altered the name of their firm to the **Chalmers-Edina Co.**

Wright and Wood Ltd., Century Works, Halifax, have changed their name to **Wright Motors Ltd.** The change has been made for private reasons only, and the business will be carried on as hitherto.

Messrs. William McLean Ltd., Stirling Chambers, Sheffield, have been appointed selling agents in the Sheffield district by Messrs. George G. Blackwell, Sons and Co. Ltd., and the British Thermit Co. Ltd., both of Liverpool, for their high-grade alloys.

Messrs. D. Home-Morton, A. Home-Morton, and G. H. L. Gibson, trading in partnership as consulting engineers and industrial works designers, at 224, St. Vincent Street, Glasgow, and 2, Eldon Street, London, E.C.2, under the style of Home-Morton and Gibson, have dissolved partnership. **Mr. D. Home-Morton** will carry on business under the name of Home-Morton, at St. Vincent Street, Glasgow, and Messrs. A. Home-Morton and G. H. L. Gibson will carry on business under the style of **Home-Morton and Gibson,** at 2, Eldon Street, London, E.C.2.

The Westinghouse Brake Co. Ltd. have appointed **Captain T. Barty,** late of the Royal Engineers, to act as their representative with the British and foreign railway companies. Captain Barty has for some time been acting as brake engineer at the base locomotive works of the British Expeditionary Force in France. He was, before the war, manager of the steam heating department of the Westinghouse Brake Co. Ltd., and previously was assistant to the outdoor locomotive superintendent of the Caledonian Railway.

Mr. Henry Willock Ravenshaw, M.Inst.C.E., consulting engineer, has taken into partnership **Mr. Charles Frederick Dyer, Assoc.M.Inst.E.E.,** who has now returned after serving for three years in the Navy. The partnership commences from January 1st, 1919, in the style of Ravenshaw and Dyer. The firm has its office at Rutland House, Hanwell, London, W.7.

Messrs. Peter Brotherhood Ltd. announce that they have commenced the manufacture of refrigerating plant on both the CO_2 and NH_3 systems. For marine refrigeration the firm is supplying plant on the CO_2 system, having a number of improvements making for increased reliability and freedom from wear. As it is accustomed to supply compressors for air, hydrogen, etc., working to pressures above 6,000 lb. the square inch, the conditions which have to be satisfied in a successful CO_2 system present no difficulty. One of the new features of the marine CO_2 installations is the type of joint employed.

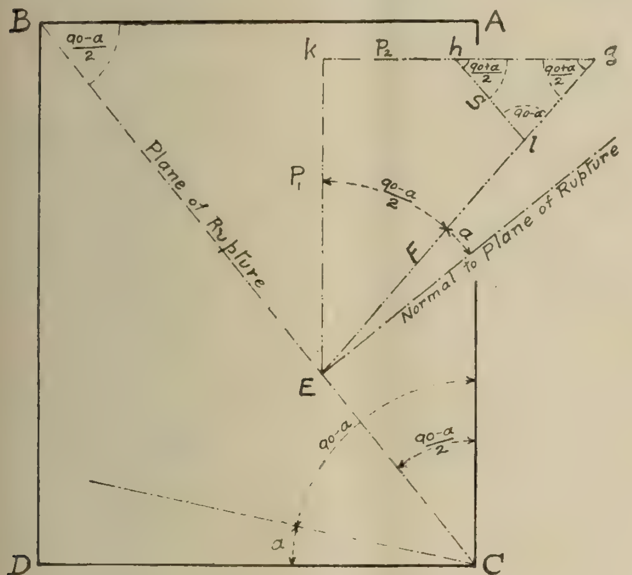
Major R. Stevenson, M.C., Inspector of Ordnance Machinery, M.I.E.S., A.M.I.Mech.E., F.C.S., Extra Chief Marine Engineer, having been demobilised after service since 1914, principally overseas together with **Dr. H. V. A. Briscoe (Lond.), D.I.C., A.R.C.S. (Lond.), F.C.S.,** are opening offices at 34, West George Street, Glasgow, as inspecting and consulting engineers and chemical engineers.

The pig-iron shipments from the port of Middlesbrough during January reached 31,381 tons, as compared with 28,513 tons in December, and 31,070 tons in November. Whilst in November and December considerable quantities were shipped to Scotland, in January only 1,370 tons went to coastwise ports, owing to the withdrawal of rebate upon shipments. Thus, the foreign shipments in January amounted to 30,011 tons, compared with 22,306 tons in December, and 21,806 tons in November. Shipments of manufactured iron and steel last month totalled 18,080 tons, of which 16,315 tons went abroad. The pig-iron shipped to France last month amounted to 13,717 tons, and the quantity cleared for Italy was 10,144 tons.

and P must not be less than this. The values of W and A are given in Table III.

The Bell Formula.

The assumptions made in the Rankine formula are fairly reasonable as regards sands and gravels, but for clays and shales they are rather debatable. In a paper read before the Institution of Civil Engineers in 1914, by Mr. Arthur L. Bell, experimental results were brought forward to show that while the shear strength of dry sand is directly dependent on the pressure across the shear plane, that of clay, although increasing with the pressure, is not entirely dependent upon it, but has an absolute initial value which should be taken into account.



Foundations.—Fig. 3.

Fig. 2 shows the relation between cross-pressure and shear strength for sand and clay. The shear strengths and values of A for clays are given in Table I. To determine the lateral pressure allowing for the shear strength of clay, see Fig. 3. CA is drawn making an angle A with the normal CD. Bisecting the angle ACD the line CB is the plane of rupture in a very small mass of clay. Taking a negligiby small prism of clay on this plane it is kept in place by the forces P = vertical pressure; F = cross-pressure; S = shear strength of clay; and P = horizontal pressure. These forces form the Polygon Ekhl. The length of $hl = k$BC where K = shear strength from Table I. and it is parallel to CB. The value of Pi is therefore $hk = kg - gh$, which

$$= P\left(\tan\frac{90-A}{2}\right) - 2\,kBC\cos\left(\frac{90-A}{2}\right)$$

The unit pressure

$$p^1 = \frac{P}{AC} = \frac{PAB}{AC}\left(\tan 90 - A\right) - \frac{2kBC}{AG}\cos\frac{90-A}{2}$$

$$= p\tan 2\left(\frac{90-A}{2}\right) - 2k\tan\left(\frac{90-A}{2}\right)$$

Table No. 1.

Material.	K ton. per sq. in.	$a°$	Authority.
Puddle clay grabbed from a monolith	·2	—	Arthur Bell.
Puddle clay grabbed from a monolith	·3	½	Do.
Puddle clay grabbed from a monolith	·4	1¼	Do.
Puddle clay hand excavated from a monolith	·45	2½	Do.
Stiff puddle clay	·62	2	Do.
Sandy clay	·6	2½	Do.
Stiff sandy clay	·5	10	Do.
Mod. firm boulder clay	·7	6½	Do.
Very stiff boulder clay fairly dry	1·6	16	Do.
Wet sand grabbed from monolith	·3	31	Do.
Values Given for Use with Formulæ.			
Very soft puddle clay	·2	—	Do.
Soft puddle clay	·3	3	Do.
Mod. firm puddle clay	·5	5	Do.
Stiff clay	·7	7	Do.
Very stiff boulder clay	1·6	16	Do.
Weakest clays	·17	—	Collins' exp., Dr. Unwin.
Average	·45	—	
Very hard clay. Hard as dry soap	5·12	—	
When shear was prolonged over 12/15 minutes the values were only about a third.			
	lbs. per sq. in.		
Dry sand	1·47	35°	Prof. Cain, Leygues' exp.
Wet sand	8·28	40	
Very wet sand	6·36	59½	
Damp fresh earth	18·45	58½	

TABLE No. 2.

Comparison of the Rankine and Bell Formulæ.

	Rankine.	Bell.
$p1$ = Intensity of active pressure on back of wall at any depth d.	$wd\left(\frac{1-\sin a}{1+\sin a}\right)$	$wd\tan^2\left(\frac{90-a}{2}\right) - 2k\tan\left(\frac{90-a}{2}\right)$
$r1$ = Maximum intensity of horizontal resistance of material in front of a wall at any depth d.	$wd\left(\frac{1+\sin a}{1-\sin a}\right)$	$wd\tan^2\left(\frac{90-a}{2}\right) + 2k\tan\left(\frac{90-a}{2}\right)$
$p2$ = Minimum permissible intensity of downward pressure on foundation depth d.	$wd\left(\frac{1-\sin a}{1+\sin a}\right)^2$	$wd\tan^4\left(\frac{90-a}{2}\right) - 2k\tan^3\left(\frac{90-a}{2}\right) - 2k\tan\left(\frac{90-a}{2}\right)$
$p3$ = Maximum permissible intensity of downward pressure on foundation at depth d.	$wd\left(\frac{1+\sin a}{1-\sin a}\right)^2$	$wd\tan^4\left(\frac{90-a}{2}\right) + 2k\tan^3\left(\frac{90-a}{2}\right) + 2k\tan\left(\frac{90-a}{2}\right)$

This horizontal thrust gives rise to an upward thrust p_2 outside the foundation

$$p_2 = p_1 \tan^2\left(\frac{90-A}{2}\right) - 2k \tan\left(\frac{90-A}{2}\right)$$

$$= p \tan^4\left(\frac{90-A}{2}\right) - 2k \tan^3\left(\frac{90-A}{2}\right) 2k \tan\frac{90-A}{2}.$$

The comparative results of the Bell and Rankine formula are given in Table II. In the discussion on Mr. Bell's paper it was brought out very clearly that clays are adversely affected by exposure and weathering. Angles of repose were quoted as ranging from 90 deg. to zero, and the shear strengths were also criticised. Mr. Bell was constrained to point out that the values of the k and A given in the tables were intended to apply to clays in their natural beds, and not to material exposed to weathering. His view was that the term angle of repose cannot properly be applied to clays and other cohesive materials. There was a general agreement that the new formulæ were an advance upon the Rankine formula, where the shear strength is not considered at all.

(To be continued.)

Table No. 3.

Safe load on various material.	Tons per sq. in.	Angle of repose.
Soft.		
Bog, morass, quicksand, peatmoss, marshland, silt	·0 to ·2	—
Slake and mud. Hard peat turf	·0 to ·25	—
Soft wet pasty or muddy clay, marsh clay	·25 to ·33	5°
Alluvial deposits in river beds moderate depth	·20 to ·25	28°
Alluvial deposits in river beds fim deposits on rock	·20 to ·75	35°
Diluvial clay in river beds	·35 to 1·0	30
Clay 60 to 80 per cent. Clay loams 30 per cent sand, alluvial earth, loams, sand 40 to 70 per cent. Damp clay	·75 to 1·5	30
Soft chalk impure and Argillaceous	1·0 to 1·5	40
Blue clay (Cleveland Viaduct)	1·0 to 1·7	—
Sandstones that will crumble in the hand	1·5 to 1·7	40°
Compact clay (chimney at Newcastle)	1·5	40°
Very soft rock	1·8	—
Medium.		
Yellow sandy clay (Busigny Bridge)	2·1 to 2·8	40°
Coarse sand and dry clay	2·25	30°
Loose sand in shifting riverbeds. Safe loads increases with depth	2·5 to 3·0	22°
Upheaved and interturned beds of different sound clays	3·0	40°
Sand (Brooklyn Bridge)	4·0	28°
Uniform firm silty sand in river bed below 25 ft. free from scour	3·5-4·0	35°
Solid clay mixed with very fine sand	4·0	40°
Sound yellow clay normal quantity of water	4·0 to 6·0	40°
Coarse gravel (Pont de jour Viaduct)	4·4	40°
Firm sand in estuaries, bays, &c.	4·5 to 5·0	35°
Firm sand in estuaries, bays, &c. Dutch engineers	5·5	35°
Compact stoney clay (Brooklyn Bridge)	5·5	40
Very firm compact sand not less than 20 ft. below surface	6·0 to 7·0	35°
Firm shale in clean gravel (protected from weather)	6·0 to 8·0	50°
Compact sand and gravel (Bordeaux Bridge)	6·78	50°
Hard.		
Limestone and Oolites	8·0 to 10·0	—
Hard sand stones	12 to 14	—
Sound clear homogeneous Thames gravel no signs of failure 5 ft. below surface	14·00	40°
Marble	16 to 20	—
Basalt, grit stone, Robinhood and Bramley Fall stones in unfissured beds	20 to 30	—
Granites in unfissured beds	30 to 50	—

MODERN STEAM TURBINES.

By J. Humphrey.

(Continued from page 164.)

Small Steam Turbines.

During recent years a considerable number of small steam turbines have been built for driving centrifugal pumps, fans, blowers and other machines of a kindred nature. Though from the point of view of steam economy, steam turbines show up to the best advantage when built in large sizes, small turbines, with outputs ranging from about 10 to 200 H.P. are nevertheless now used to a considerable extent. A Westinghouse machine of this kind, made

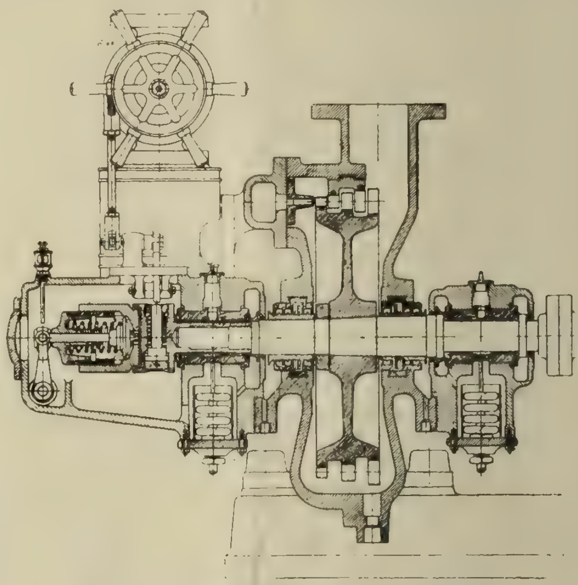


Fig. 78.—A Westinghouse Small Turbine.

in sizes ranging from 25 to 200 kilowatts. is shown in Fig. 78. It will be seen that the rotating element consists of a single-velocity wheel, which in this particular case carries three rows of moving blades with fixed guide blades between them. Sometimes there are only two rows of moving blades, the number depending upon the steam conditions and the available heat drop. These machines are extremely light and compact, and require practically no attention. In the nozzles the steam is expanded and made to acquire kinetic energy, which is utilised in the blades on the running wheel. Assuming that there are two rows of running blades, after the steam leaves the nozzles it strikes the first row of blades and then passes into the fixed blades, which direct the steam to the second row of blades mounted on the rotor.

Half the kinetic energy of the steam is therefore expended in one row of the moving blades, and the other half in the other row. The speed of the rotor is consequently lower than it is in turbines in which the whole of the kinetic energy is absorbed in a single set of moving blades. If there are three rows of moving blades, as in Fig. 78, then of course the velocity is used up in three steps or stages. Turbines of this sort are built for speeds of about 3,000 or 4,000 revolutions per minute, and, consequently, they can be directly connected to centrifugal pumps and other similar machines.

A section of a small steam turbine with only two rows of blades on the running wheel is shown in Fig. 79; this machine, like that shown in Fig. 78, being simply compounded for velocity. The governor, it will be noticed, is driven by a worm wheel mounted on the main shaft, and it controls the supply of steam by regulating the throttle valve. Small steam turbines, like those constructed for large outputs, can also be divided into pressure stages as well as velocity stages, but for ordinary steam pressures a simple rotor compounded for velocity is commonly employed.

In the case of some small steam turbines—the Sturtevant turbine—the nozzles are arranged around the periphery of the rotor, and reversing buckets are also provided as shown in Fig. 80. The steam enters an annular chamber A, from which it passes into nozzles, and afterwards impinges on the rotor or bucket wheel. As shown by the arrows at B, its direction of flow is then reversed, and it enters the reversing buckets just above the wheel, and in these buckets the direction of flow is again reversed and the steam is once more directed forward on to the running wheel. The expansion of the steam occurs

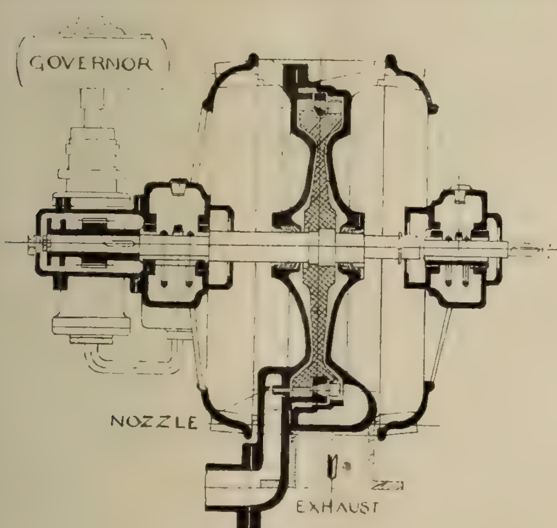


FIG. 79.—A SMALL TURBINE: TWO ROWS OF ROTOR BLADES.

entirely in the nozzles and the steam does not enter the exhaust until its velocity has dropped to practically that of the rotor. Clearly by passing the steam through the rotor buckets several times the same effect is secured as by passing the steam through several rows of moving blades, and the speed of rotation is reduced to a value which enables the turbine to drive pumps and similar machines without the use of reduction gearing. Turbines of this kind are frequently compounded for pressure as well as velocity. Instead of the full pressure drop occurring in only one set of nozzles, it occurs in two separate sets which supply steam to two separate rotors mounted on a common shaft, and each rotor, together with its nozzles and reversing buckets, constitutes a pressure stage. The two stages are connected in series so that after the steam has passed through the first stage it enters the second stage through the

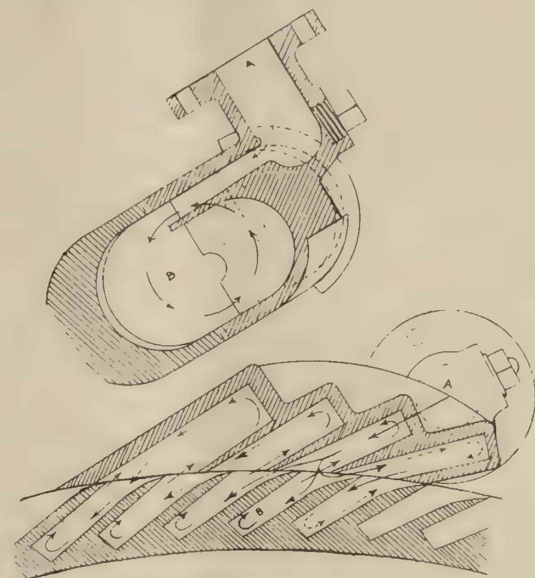


FIG. 80.—PORTION OF ROTOR AND REVERSING BUCKETS.

second set of nozzles and return boxes, arranged around the periphery of the second wheel in the same manner as the nozzles and return boxes belonging to the first wheel. As a rule, the bearings of small steam turbines are lubricated with oil rings, and it will therefore be seen that altogether the amount of attention that a small turbine requires is almost a negligible quantity.

(To be continued.)

EFFICIENCY OF AN ELECTRIC KETTLE.

By G. E. GITTINS, B.Sc. (Lond.)

A short time ago the writer had occasion to carry out investigations into the efficiencies of a number of electric kettles. The following data collected on a kettle made by a well known firm may be taken as typical of the results obtained:—

Size of kettle: One quart.

Material: Nickelled copper.

Rating of heating element: 220 volts, 50 periods.

Mean current: 3·3 amperes.

Apparent input = 726 volt amperes.

True input = 715 watts.

Mean power factor = 98·5 per cent.

Initial temperature of kettle and water = 15·8 deg. C.

Mean room temperature = 19·5 deg. C.

Time taken from "switch-in" to reach boiling point = 11 min. 10 sec.

The commercial efficiency is obtained as follows :—

Mass of 1 quart of water = 2·5 lbs. = 1134 gms.

Heat required to raise the temperature of the water from 15·8 deg. C. to 100 deg. C.

= 1134 gms. × 84·2 deg. C.
= 95600 calories.
= $4{\cdot}018 \times 10^5$ joules.

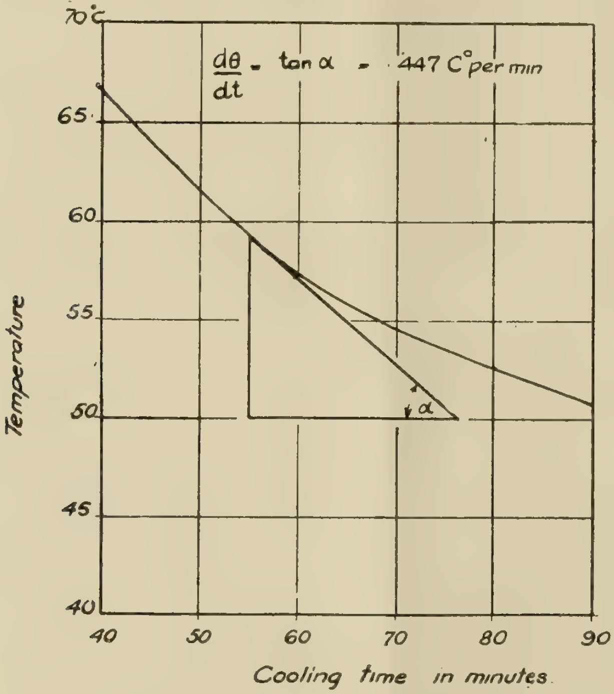
Board of Trade units usefully employed = ·1115.
Actual energy used in Board of Trade units

$$= \frac{715 \text{ watts} \times 670 \text{ sec.}}{36 \times 10^5 \text{ joules}} = {\cdot}133.$$

Hence commercial efficiency

$$= \frac{{\cdot}1115}{{\cdot}133} \times 100 = 84 \text{ per cent.}$$

The cooling curve, see illustration, was plotted, and the rate of fall of temperature at the mean temperature of kettle and water obtained.



The rate of dissipation of heat energy by radiation could now be determined.

Thus :—

Mass of kettle	= 2·5 lbs. = 1134 gms.
Water equivalent	= 113·4 gms.
Total water equivalent	= (1134 + 113·4) gms.
	= 1247·4 gms.

By curve, rate of fall of temperature at the mean temperature = ·447 deg. C. per min.

Radiation loss

= 1247·4 gms. × ·447 deg. C. per min.
= 558 calories per min.
= 39 watts say.

Expressed as a percentage of the mean power input this is $\frac{39}{715} \times 100 = 5{\cdot}5$ per cent, leaving 10·5 per cent unaccounted for.

WORKED EXAMPLES IN APPLIED MATHEMATICS.

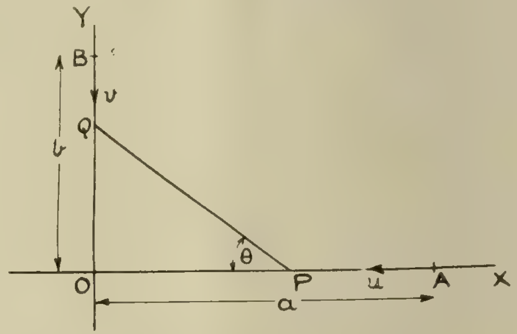
By G. E. Gittins, B.Sc. (Lond.).

(*Continued from page 183.*)

Example 5.—Two points are moving with uniform velocities, u, v in perpendicular lines O X, O Y, the motions being towards O. When $t = 0$ they are at distances a, b, respectively from O. Calculate the angular velocity of the line joining them at time t and show that this angular velocity is greatest when

$$t = \frac{a u + b v.}{u^2 + v^2}$$

Solution.—Referring to Fig. 4, let P, Q be the positions of the points at time t after start, and A B the



Applied Mathematics.—Fig. 4.

initial positions at time $t = 0$. Then we get at once that $OP = a - ut$; $OQ = b - vt$. If θ be the angle Q P O, then $\tan\theta = \frac{b - vt}{a - ut}$. Differentiating with respect to t we have

$$\operatorname{Sec}^2\theta \frac{d\theta}{dt} = \frac{(a - ut)(-v) - (b - vt)(-u)}{(a - ut)^2}$$

$$= \frac{bu - av}{(a - ut)^2}.$$

$$\text{Also } \operatorname{Sec}^2\theta = (1 + \tan^2\theta) = \frac{PQ^2}{(a - ut)^2}$$

$$\therefore \text{ the angular velocity } w = \frac{d\theta}{dt}$$

$$= \frac{bu - av}{(a - ut)^2} \times \frac{1}{\operatorname{Sec}^2\theta}$$

$$= \frac{bu - av}{PQ^2}$$

$$\text{But } PQ^2 = (a - ut)^2 + (b - vt)^2$$

$$\text{Hence } w = \frac{(bu - av)}{(a - ut)^2 + (b - vt)^2}.$$

Now this angular velocity w is greatest when $(a - ut)^2 + (b - vt)^2$ is least.

Put $y = (a - ut)^2 + (b - vt)^2$,

$$\text{then } \frac{dy}{dt} = -2(au + bv) + 2t(u^2 + v^2)$$

= 0 for a maximum or minimum value.

$$\therefore t = \frac{au + bv}{u^2 + v^2}$$

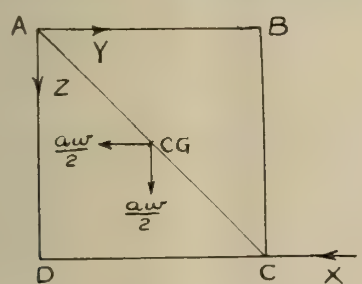
As there is no other stationary point, and $(u^2 + v^2)$ can be infinity, therefore this value for t must make the denominator $(a - u\,t)^2 + (b - v\,t)^2$ a minimum or w a maximum.

Example 6.—A uniform circular disc lies on a horizontal plane. Find the magnitude of the vertical impulse which must act at a given point (not the centre), so that it may rise and fall rotating through π radians while in the air. Assume that the disc rises free of the plane at once.

Solution.—We shall denote the impulse by $\dot{F}$ where $\dot{F}$ is defined as the time integral $\int F\,d\,t$ of the impulsive force F. The two following facts must be kept in mind:—(*a*) the rate of change of the translational momentum is equal to the resultant of the applied forces, and (*b*) the rate of change of the angular momentum about the C. G. is equal to the moment of the applied forces about that point.

Let the impulse $\dot{F}$ be applied to the disc at a distance x from the centre. Then the moment of the impulse is $\dot{F}\,x$ and this, by the principle stated above, must equal the change in the angular momentum of the disc about an axis through its C. G.

Hence $\dot{F}\,x = M\,k^2\,w$, where k is the spin radius of the disc about a diameter and w the initial angular velocity.



Applied Mathematics.—Fig. 5.

Note that in the subsequent motion w does not alter since no couple acts. Also $\dot{F} = M\,u$ where u is the initial linear velocity. Now the C.G. of the disc rises for a time, $t = \frac{u}{g}$ and total time in air, rise and fall, is $2\,t = \frac{2\,u}{g}$. The disc rotates in this time through π radians and therefore $\frac{\pi}{w} = \frac{2\,u}{g}$ or $2\,wu = \pi g$.

But $u = \frac{\dot{F}}{M}$ and $w = \frac{\dot{F}\,x}{M\,k^2}$

$$\therefore \frac{2\,\dot{F}\,x}{M\,k^2} \times \frac{\dot{F}}{M} = \pi\,g\,;$$

$$\text{or } x = \frac{\pi\,g.\,M^2\,k^2}{2\,\dot{F}^2}$$

$$\text{and } \dot{F} = \sqrt{\frac{\pi\,g}{2\,x}}.\ M\,k.$$

Example 7.—A uniform square lamina A B C D lies on a horizontal plane, and is free to turn about the corner A, which is fixed. A blow is struck at C along the edge C D. Prove that there is an impulse at A which bears to the blow the ratio $\sqrt{10} : 4$.

Solution.—Let the initial angular velocity be O, and that after the blow be w. If a be the side of the square, then the velocity of the C. G. after the blow has components $\frac{a\,w}{2}$ parallel to C D and B C respectively. There is a reaction at A; call its components Y and Z as drawn in Fig. 5.

$$\text{Then } X - Y = \text{impulsive force parallel to C D} = \frac{M\,a\,w}{2} \qquad \text{I.}$$

$$\text{Similarly } Z = \text{impulsive force parallel to B C} = \frac{M\,a\,w}{2} \qquad \text{II.}$$

Taking moments about the C. G. we get

$$(X + Y - Z)\,\frac{a}{2} = M\,k^2 w = \frac{M\,a^2}{6}\,w$$

since $k^2 = \frac{a^2}{6}$ for an axis through C.G. at right angles to the plane of the lamina.

Insert the values of Z and Y from II. and I. in $(X + Y - Z)$ and we have

$$\text{that } \frac{a}{2}\left\{ X + X - \frac{M\,a\,w}{2} - \frac{M\,a\,w}{2} \right\} = \frac{M\,a^2}{6}\,w$$

$$\text{that is } \quad X = \frac{M\,a\,w}{2} = \frac{M\,a\,w}{6}$$

$$\text{and } \quad X = \frac{2}{3}\,M\,a\,w \qquad \text{III.}$$

$$\text{Also } \quad Y = X - \frac{M\,a\,w}{2} = \frac{M\,a\,w}{6} = \frac{X}{4}$$

$$\text{And } \quad Z = \frac{M\,a\,w}{2} = \frac{3\,X}{4}$$

$$\text{Impulse at A} = \sqrt{Y^2 + Z^2} = \sqrt{\frac{X^2}{16} + \frac{9\,X^2}{16}} = \frac{\sqrt{10}}{4}\,X.$$

$$\therefore \text{ the ratio } \frac{\text{Reaction at A}}{\text{Blow at C}} = \sqrt{10} : 4$$

(To be continued.)

THE INSTITUTION OF CIVIL ENGINEERS.*

THE FLOW OF WATER IN PIPES AND PRESSURE TUNNELS.

By Frederick John Mallett, Assoc.M.Inst.C.E.

The paper is an endeavour to trace out the inconsistencies met with in many of the older formulæ, and briefly to set out the features that in practice determine the ultimate capacity of water-mains.

Practically all the better-known formulæ have been examined and compared, and the formulæ giving the most consistent results over a range of diameters from 3 in. to 120 in. have been tabulated. It was found that many of the formulæ gave good results over a short range of diameters, but when

* Abstracts of two papers read at the ordinary meeting of the Institution, on Tuesday, the 25th February, 1919.

extended to the diameters that are now coming into use they gave unreliable results. This is no reflection upon those who originated the formulæ, as prior to 1910 only about a dozen pipes over 48 in. in diameter had been tested.

The well-known Kutter-Flynn tables with a value of 0·013 for n have been extensively used by waterworks engineers, but while giving good results for mains, say, from 12 in. to 36 in. in diameter, for mains of small diameter the capacity was found to be greater than the formula predicted, although the incrustation was the same in amount and character. This knowledge has compelled the adoption of a smaller value of n for pipes below 12 in. or so in diameter; or indeed sometimes of another formula. The necessity for two formulæ or two valves of n to determine with a degree of accuracy the discharge of mains similarly encrusted is objectionable.

It was with the idea of obtaining greater accuracy in determining the flow of water in incrusted mains that tests were made upon mains 3 in. to 30 in. in diameter, and upon their entire length, not in short sections or straight runs. These mains have been in use from 20 to 60 years, and the water is derived from the limestone and red sandstone formations, which produces an incrustation corresponding to Kutter's $n = 0{\cdot}013$. About the time these tests were completed (1916), Mr. F. C. Scobey's work on wood-stave pipes (Bulletin No. 376, U.S. Department of Agriculture) was issued. The experiments were made upon mains 8 in. to 162 in. in diameter, and form reliable data upon which to construct formulæ for mains up to about 15 ft. in diameter. Since the date of Scobey's bulletin, the tests upon the New York water-supply tunnels of 14½ ft. diameter have been issued, and these have been considered in the development of a new set of formulæ for clean and incrusted mains.

It has been noted that in the past the greatest attention has been paid to the determination of coefficients and indices in formulæ for clean mains, and then a very wide margin allowed for incrustation or ageing. Generally the allowance for incrustation is the same relative amount for the large mains as the small mains, which is not tenable. Several expressions have been introduced to determine the reduction in capacity of mains in a term of years, but these are also inconsistent with fact, since the incrustation depends more upon the class of water conveyed by the main than upon the number of years that the main has been in use.

New formulæ for clean and incrusted mains are given; the nature and degree of incrustation is stated for each of three degrees of incrustation; and a general classification is made of waters which produce these incrustations. A survey of formulæ and of the subject leads to the conclusion that the Chezy formula, with a varying value of C determined from the value of n introduced, as ascertained from the class of water to be dealt with, is the best for practical purposes.

THE DISCHARGE OF LARGE CAST-IRON PIPE-LINES IN RELATION TO THEIR AGE.

By Alfred Atkinson Barnes, Assoc.M.Inst.C.E.

Dealing first with the general methods of conveying water from a catchment-area by means of aqueducts which combine masonry conduits with cast-iron pipe-lines, the author points out that the sizes of the former portions are usually made, in the first instance, of a capacity sufficient to convey the whole of the anticipated yield.

The pipe-lines, however, are usually laid by instalments, the time intervals between these being primarily determined by the progressive increase in the consumption of water as found from the town's supply statistics.

Hence it is important that the individual discharging capacities of the several pipe-lines should be accurately known from year to year, and the author therefore deals in this paper with the subject of the diminution in those discharging capacities as caused by incrustation.

The paper is an attempt to reduce to a definite law the relation between the effect of incrustation of the mains on the one hand, and the number of years that these have been in use on the other; and the results are based upon observations carried out in the past upon the flow in the pipes of the Thirlmere Aqueduct, which supplies Manchester with water from the Lake district.

A table of experiments is given showing the hydraulic gradients and the recorded flow in pipes of 44 in. and 40 in. diameter, after these have been in use for various periods. The results are plotted on a diagram, and a law is given relating the age of the pipes with the diminution in discharge. These diminutions are expressed as percentages of the discharge of a new asphalted pipe, which is presumed to work at the particular net hydraulic gradient which existed during each experiment.

A formula is given for the discharge of the clean asphalted cast-iron pipe, and a diagram is included —based on this formula—from which the quantity passing in pipes ranging from 24 in. to 60 in. in diameter, when new, can be read off.

The author's formula for this clean discharge is:—

$Q = 47{\cdot}087\ d^{\,2{\cdot}769}\ i^{\,0{\cdot}529}$ cubic feet per second, the dimensions being in feet.

The actual flow found by experiment in the incrusted pipe is compared with the flow in the clean pipe as given by the above formula; and the results have led the author to adopt for the pipes in question the following equation, to represent the diminution in discharge with age:—

Percentage diminution in discharge = 13 (age of pipe in years) $^{0{\cdot}37}$.

In view of the seriousness of the rate of decrease of flow in the early years, tht policy is suggested of adopting some system of cleaning the pipes before the incrustation is very far advanced.

Engineers in charge of other aqueducts are invited to test the formula on large pipe-lines which have been conveying soft moorland water for some years, in order that the design of pipe-lines in the future may be based upon some agreed percentage reduction in discharge when compared with that of a clean pipe.

Further utilisation of Norway's water power is being made in connection with a new harbour works at Haugsund. A hydro-electric station is to be erected at Etne Waterfalls, where about 50,000 H.P. is available. The falls are thirty-seven miles from Haugesund, and power will be transmitted at 60,000 volts. The distribution will be made at 10,000 volts pressure.

BRITISH INDUSTRIAL "SAFETY FIRST" ASSOCIATION.

As an evidence of the necessity which exists for immediate action, the latest published returns show that, in 1914, 969 persons were killed, and 147,045 were injured by accidents in workshops and factories *alone*, a large proportion of which would, undoubtedly, have been prevented had those who became casualties been educated in matters pertaining to their own safety. Millions of pounds paid in compensation, and huge sums of money lost to workers as wages, might have been saved and utilised to better advantage, and untold suffering have been obviated.

Many of the largest firms and Trades Unions in the country are actively supporting the movement, and it is hoped to proceed at once with the preparation of "Safety" notices and literature specially suited for individual industries, which will be supplied free to the firms who become members of the Association. The experience of those firms, both in this country and in America, which have undertaken a scientific "Safety First" Campaign, proves that, from the financial standpoint alone, many hundreds of thousands of pounds are readily saved. The offices of the above-named Association are at 31, Westminster Broadway, S.W. 1.

FRACTIONAL COMBUSTION.

In the *Journal of the American Electro-chemical Society* Mr. W. D. Bancroft reviews the present knowledge of the relative rates of combustion of various gases, especially in the presence of catalysts, reference being made to the work of Henry, Hempel, Bone, Landolt, and Calvert. The following are some of the conclusions drawn. At low temperatures the nature of the catalyst may determine which of the two combustible gases will burn more rapidly; in the presence of platinum hydrogen burns more readily than methane or ethylene; in the presence of copper oxide at 250 deg. Cen. all the free hydrogen, in a mixture of this gas and methane, can be burned without the decomposition of any of the methane; in the presence of fireclay ("chamotte") at 500 deg. Cen. hydrogen burns more readily than methane; in borosilicate glass bulbs at 300 deg.—400 deg. Cen., methane, ethane, ethylene, and acetylene undergo oxidation much more rapidly than hydrogen or carbon monoxide. The relative rates of combustion of hydrogen and carbon monoxide depend on the conditions, and in a mixture of methane and oxygen with hydrogen or carbon monoxide exploded by an electric spark, the methane burns more rapidly than either hydrogen or carbon monoxide. By suitable selection of the catalyst with a mixture of methane, hydrogen, and oxygen, it should be possible to obtain all intermediate stages from complete combustion of methane to that of hydrogen, and it appears probable that in the absence of solid catalysts and at high temperatures methane burns more readily than hydrogen. At very high temperatures, also, the specific effect of the solid catalytic agent will become negligible.

DEATH OF MR. JOHN JAMES ROYLE.

We regret to announce the death of Mr. John James Royle, head of Royles Limited, Irlam, near Manchester. Mr. Royle had been in somewhat failing health for some time, but had pursued his business activities until within a few days of his death. He was in his 69th year. Before going into the engineering business, some forty-five years ago, Mr. Royle was a patent agent. He was a man of high inventive ability, and his inventions connected with steam traps, reducing valves, etc., were numerous. His most recent invention was for an automatic thermo-feed apparatus for returning hot condensation water and new feed water at very high temperatures without the usual feed pump or injector. The firm originally started business in King Street West, Manchester, but the premises becoming inadequate,

The Late Mr. John James Royle.

more commodious works were built at Irlam. These works now employ over 400 hands. Probably the chief instrument in the development of the firm's business was the invention of the "Row" tube, which is formed of solid drawn copper pipe, made with cross indentations, intersecting each other at right angles. This simple expedient secures a thorough breaking up and agitation of the central core of liquid, thus improving the heat transmitting efficiency. Another obvious advantage of this indenting process is that it imparts to the tube a certain amount of resiliency, so that expansion and contraction are allowed for. Mr. Royle did not take a very active part in public affairs, but he was a Justice of the Peace for Lancashire. A few days after Mr. Royle's death his widow, unfortunately, died.

"The Advocate"—journal of the Austin car owners—for February contains matter of much interest. The continued matter relating to testing materials for the Austin car conveys, in a clear and emphatic manner, the great care taken in the selection of materials for car construction. Topically interesting is the short note on French motoring terms. As usual, "The Advocate" is well "gotten up," and very attractive.

An ordinary meeting of the Institution of Civil Engineers will be held at Great George Street, Westminster, S.W.1., on Tuesday, March 25th, at 5.30 p.m. The papers to be further discussed are: "Electric Welding Developments in Great Britain and the United States of America," by James Caldwell and Henry Bailey Sayers; "Experiments on the Application of Electric Welding to Large Structures," by Westcott Stile Abell, M.Eng., M.Inst.C.E.; "The Application of Electric Welding in Ship Construction and Repairs," by John Reney Smith.

Trade Items, Notes, &c.

A material which, it is claimed, makes an excellent insulator for heat and cold has been produced from the lowest grades of waste paper by Mr. L. Edwards, of Twickenham.

It is stated that a factory has been started at Gothenburg, in Sweden, for the manufacture of mica insulating materials, and that supplies will be derived entirely from native sources, the concern having its own mines.

At the time when war was declared arrangements were completed for holding the Shipping, Engineering, and Machinery Exhibition at Olympia, and it has now been decided to resume immediately the organisation of the exhibition, and, if possible, to arrange for it to be held in the autumn of the present year.

The number of electrically-driven coal-cutting machines in use in this country at the end of 1917 was 1,739, an increase of 149 over the number in use at the end of 1916. The total horse-power of electric motors in use on the surface and underground was 913,640, of which 521,000 H.P. was in use underground.

Tests carried out by the London Hydraulic Power Company showed considerable economy when coke was mixed with the coal for its water-tube boilers. Coke was added in proportions of from 30 to 75 per cent. The steaming capacity of the boiler was increased by over 20 per cent, and the over-all efficiency rose from 61 to 70 per cent.

Letters patent have been granted to Mr. W. D. Berry, President of the Berry Metal Company, New Brighton, Pa., for a tinless phosphor-bronze bearing metal. During the war, and while the Government was pleading for everyone to conserve tin, Mr. Berry made experiments, the outcome of which has been the development and perfecting of the tinless bearing metal in question.

It is announced that the Russian Government has decided to introduce the metric system of weights and measures, and all traders will be required to quote their prices in future in both the old and the metric system. It is expected that the new system will be adopted throughout Russia by the end of next August, and it is understood that from the end of 1924 the use of the old system will be prohibited in that country.

A report has been issued by the Japanese Government on the work of the committee which has been conducting an investigation into the standardisation of freight ships. It is claimed that the adoption of standards in the building of freighters will facilitate the supply of materials and enhance the efficiency of the yards, and will also reduce considerably the cost of ships.

When copper was "mobilised" in Germany in the beginning of 1916, instrument makers had to find a substitute for the brass of which they had been making so large a use. In many cases iron and steel proved quite serviceable, though there was trouble because the iron castings were not always so neat and accurate as the brass castings, there having been less demand for iron castings of high finish. The chief material utilised was, however, zinc, as such, and in various alloys. Nickel for electro-plating becoming likewise scarce, cobalt was successfully adopted; in general, the alloys were merely varnished. That iron, zinc, and aluminium have also become important materials for electrical engineers, has been mentioned on other occasions. Various impregnated cellulose preparations have been introduced as insulating materials under the name of cellon, tenazit, turbonit, wenjazit, etc.

Messrs. Harland and Wolff Ltd., who have shipyards on the Clyde as well as at Belfast, have arranged to amalgamate with Messrs. David Colville and Sons Ltd., and thus secure a supply of materials at cost price. Some of the Tyne shipbuilders joined hands many years ago with engineering and other allied companies, and the arrangement has to all appearances proved satisfactory. Messrs. David Colville and Sons, whose issued capital is £1,050,000, began with steel works at Motherwell, and have since acquired the undertakings of the Glengarnock Iron and Steel Co., the Glengarnock Chemical Co., and the Clyde Bridge Steelworks, Rutherglen. They have also held a controlling interest in Mesrs. Archibald Russell Ltd., coalmasters, Glasgow, for the last two years. Messrs. Harland and Wolff's authorised capital is £1,600,000, of which, it would appear, a little under £1,000,000 has been issued.

The light from the tungsten arc is essentially whiter than that of gas-filled glow-lamps; the consumption is stated in the *Science Abstracts* of the Institution of Electrical Engineers to be 0.4 watts per candle-power, and the intrinsic brilliancy about 40 Hefner candle-power per square millimetre. The lamp is rich in actinic rays, and the nature of the source lends itself to projection and ultra-microscopic work.

The receipts of the Mersey Dock and Harbour Board for the year ended July 1st last, amounted to £2,403,471, the chief item of which was £1,682,257 for dock rates and dues. On the expenditure side over a million was paid in interest on borrowed money (the Board having utilised its borrowing powers to the extent of over thirty-two millions), nearly half a million was expended by the engineers' department in the upkeep of waterways and docks, and £100,000 was carried to sinking fund. Other statistics show that during the year 11,855 vessels, of a total tonnage of 11,687,204, entered the Mersey, and paid dock and harbour rates and dues. These figures show a decrease of 4,892 vessels and 2,331,448 tons on the figures for 1917. The total rates and dues the ships paid was £1,758,677, an increase of £232,893 over the previous year, thus showing the extent to which rates and dues have been advanced to meet increasing charges. It is of interest to note that the tonnage of vessels entering the port and paying rates, etc., last year is the smallest since 1897, while the number of ships is actually fewer than in any year since 1830, but the amount of rates and dues paid by them constitutes a record.

During the past month twenty vessels of 20,220 tons have been launched from Scottish shipyards. Of that number ten of 15,117 tons were built on the Clyde, five of 2,236 tons on the Forth, one of 1,900 tons on the Tay, and four of 967 tons at Aberdeen and Inverness. No monthly returns for the war period have been published, but the Clyde return in January, 1914, was eleven vessels of 22,272 tons. Of the vessels launched on the Clyde two were between 5,000 and 6,000 tons, one an oil carrier for Messrs. Hunting and Sons, London, and the other a standard ship for the Shipping Controller. Many vessels are in hand, and it is said that fresh contracts are plentiful. The only new orders published, however, are those given to the Fairfield Company for two large steamers for the Anchor-Donaldson Line, to Scott's Shipbuilding and Engineering Company (Limited), Greenock, for four cargo steamers of 9,000 tons each for the Donaldson Line, and to William Denney and Brothers, Dumbarton, for four cross-Channel steamers for the London and North-Western Railway Company's Holyhead-Dublin service.

Queries and Replies.

We shall at all times be pleased to help our readers out of their difficulties to the best of our power, and invite them to make use of this column for that purpose.

C. Gregory (Manchester).—Your article has been accepted, and will appear in an early issue.

J. Scott (London).—We have received your contribution, and will endeavour to use it as soon as possible.

J. F. (Bedford).—Yes, we are quite interested in the subject you refer to. Let us have the synopsis as early as possible.

Engineer (Lincoln).—The policy of the Association you refer to is educative, principally, in order to improve the status of its members. It is alive to the remunerative side as well, naturally, and there is room for considerable improvement in this direction.

Apprentice (Newcastle).—We have already arranged for articles on the subjects named. A series on "Cams" will commence in our next issue.

H. L. S. N. (Dundee).—Thanks for your appreciation of Mr. J. Humphrey's reply to your query on "Exhaust Steam." Your cheering words make life worth living.

Pyrometer (Halifax).—Yes, it is intended to publish the articles in book form later.

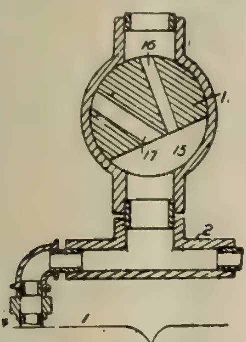
Patent Applications.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

ABSTRACTS OF SPECIFICATIONS.

INTERNAL-COMBUSTION ENGINES.

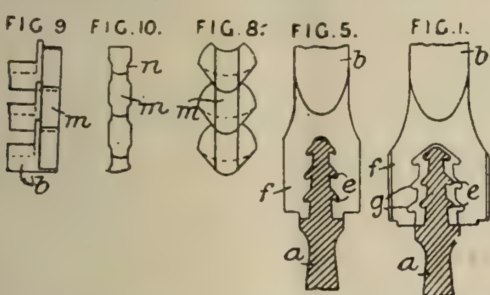
119,186.—F. A. Coles, Miami, Florida, U.S.A.—Feb. 15th, 1918.—Heated air is admitted to the induction pipe 1 through a pipe



2 and valve 11 which has two passages 16, 17 of different diameters leading to a segmental recess 15 on the delivery side.

TURBINES.

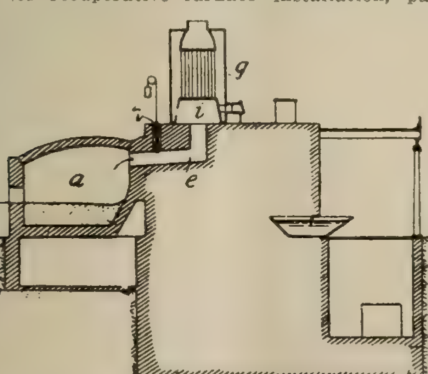
119,197.—Brush Electrical Engineering Co., 11, Arundel Street, Strand, London.—July 17th, 1917.—Relates to blade-fixing devices of the kind described in Specification 108,162, wherein the blades *b* are provided with forked bases *f* having notches *g* engaging projections *e* on the supporting members *a*, and consists in subjecting the shanks *f*, Fig. 1, to a series of pressing operations culminating in a pressure causing a permanent



deformation thereof, Fig. 5, so that the inner tensions set up maintain necessary contacts, including contact between adjacent blade shanks, in spite of the expansions due to centrifugal force and heat. The heads *m* of the blades, Figs. 8 and 9, may be subjected to similar pressures at the joints, the operation producing recesses *n*, Fig. 10.

STEAM-GENERATORS.

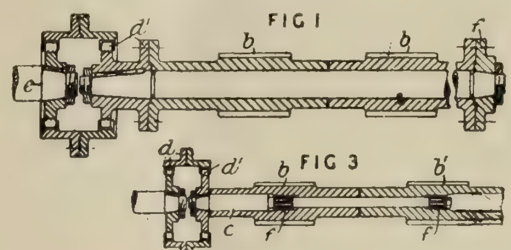
119,202.—E. W. Harvey and E. W. Harvey Gas Furnace Co., 10, Queen Anne's Gate, Westminster.—May 4th, 1918.—In a regenerative or recuperative furnace installation, part of the



furnace flame is diverted into the fire-box or flues of a steam-boiler. The regenerative furnace *a* has a separate flue *e* arranged between the usual gas inlet and outlet ports, and leading to the fire-box *i* of a boiler *g*. A damper *h* is fitted in the flue. The boiler may be arranged directly above the crown of the furnace. A boiler is shown fitted above a furnace of the kind described in Specification 23534/09.

TOOTHED GEARING.

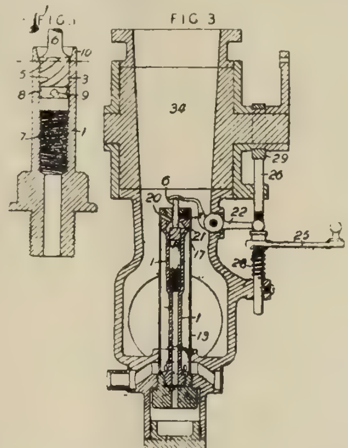
119,213.—D. Brown & Sons and A. Sykes, Park Works, Lockwood, Huddersfield.—Oct. 4th, 1917.—In order to reduce torsional deflection, neutralise end thrusts, and give a uniform distribution of the load in helical and other toothed reduction gearing for turbines, etc., long pinions are made in two hollow parts *b*, *b*1 driven respectively by couplings from an internal shaft The internal shaft, Fig. 1, is driven from the turbine, etc., shaft *e*



through a claw coupling and is connected by flanged couplings *d*1, *f* respectively with the pinion sections *b*, *b*1. In the form shown in Fig. 3, each part of the divided pinion *b*, *b*1 is separately driven by longitudinal projections *f* on the internal shaft *c* which is driven from the turbine by a straight-toothed claw coupling *d*, *d*1. In a modification of the construction shown in Fig. 1, the pinion *b*1 is made integral with the internal shaft.

INTERNAL-COMBUSTION ENGINES.

119,247.—W. Javes, Norton Villa, Osmaston Park Road, Derby.—March 21st, 1917.—The fuel nozzle of a spray carburettor comprises a helically-grooved plug 3 adjustable axially by a rod 6 in the nozzle tube 1 which is coned internally at 10 to deliver the spray as a conical sheet. The plug has an axial passage 7 leading through radial ducts 9 to a circumferential groove 8 which feeds the helical grooves 5 which become deeper and wider from the top downwards or *vice versa*. In the form shown in Fig. 1, the plug is adjusted by screwing, but in the form

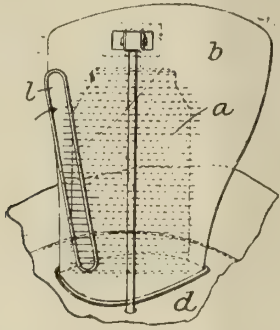


shown in Fig. 3, it may be adjusted by being pushed up or down independently or, through a lever 22, rod 26, and cam 29, in conjunction with the movements of the throttle valve 34. The rod 26 is forced against the cam by a spring 28 and carries an arm 25 which forms a bearing for the lever 22 and is adjustable from a distance. The nozzle tube 1 is enclosed by a tube 13 through which, and apertures 17 in the nozzle head, air passes to mix, in the double conical nozzle chamber 21, with fuel before it is discharged through the passages 20. The air may be heated to prevent the nozzle from freezing particularly on aircraft. In a further modification of the nozzle, the passages 20 lead to helical channels between the nozzle head and tube 13, the channels being of opposite hand to those in the plug 3.

INTERNAL-COMBUSTION ENGINES.

119,280.—H. S. Cuthbertson, Packington Road, Ashby-de-la-Zouch, Leicestershire.—Sept. 27th, 1917.—Each cylinder of an aircraft engine is enclosed by a casing of stream-line form or section in order to diminish air resistance. The invention is illustrated as applied to a radial-cylinder engine, which may be stationary or rotary. In the latter case, the casings *b* are of slightly twisted form, the axis of any given section being in the direction of the resultant of the speed of rotation and the flight velocity of the machine. The casings may be provided with slots *l* for the admission of air for cooling the cylinders, the air escaping through a conoidal central casing *d*, to which the casings *b* are secured. The casings may be of copper, aluminium, etc., and the cylinders *a* may have cooling-fins or a water jacket. The casings may be adjustable in accordance with changes in the speed of the machine, the adjustment being effected by means of a control band having rack teeth engaged by a hand-actuated pinion; the control band extends around the central casing *d* and

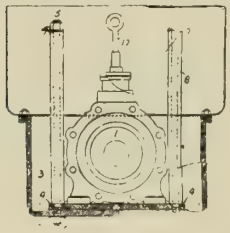
is bolted to the base-plate of each casing *b*, the base-plate being connected to the casing *d* by a pin-and-slot connection allowing a

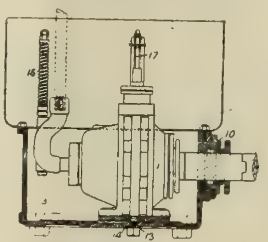


limited rotation. When the casing *d* overlaps the fixed part of the machine, a fixed ring is provided to prevent the outward creep of oil.

HYDRAULIC TRANSMISSION OF POWER.

119,276.—R. F. CAREY, 6, The Broadway, Leigh, Essex.—Sept. 25th, 1917.—In means for the transmission of power by liquid under pressure, a pump 1 is completely immersed in liquid in a tank 3, the securing means being such that the pump may be readily removed from and replaced in its correct position without the necessity of emptying the tank. The pump is provided with

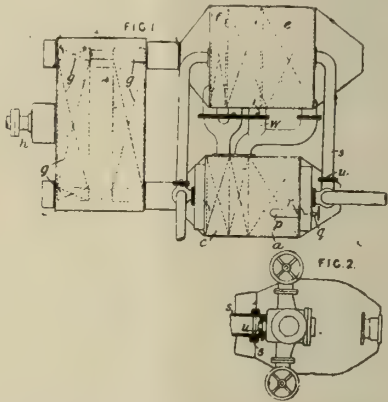




a recess 14 adapted to engage a projection 13 on the tank bottom and with holes 4 passing over studs 5 secured to the tank, is secured by distance pieces 8 and nuts 7, and is driven through a coupling, preferably of the Oldham type, passing through a stuffing-box 10 in a wall of the tank, the nuts 7, the pump control 17, and the means for adjusting the spring 16 controlling a relief valve being thus in accessible positions.

TURBINES.

119,322.—BRITISH THOMSON-HOUSTON CO., 83, Cannon Street, London.—(C. G. Curtis, 2, Rector Street, New York, U.S.A.).—Nov. 2nd, 1917.—Relates to marine turbine installations comprising a number of elements mounted on separate shafts geared to a common propeller shaft, and consists in the insertion of pressure-reducing nozzles in certain of the steam conduits to prevent overloading of the gearing in the event of one or other of the elements breaking down and in other circumstances. In a plant comprising high-pressure ahead and astern turbines *a*, *c* and



low-pressure ahead and astern turbines *e*, *f* driving a propeller shaft *h* through gearing *g*, a conduit *s* supplies live steam to the low-pressure turbine *e* in the event of the high-pressure turbine breaking down, and this conduit *s* is fitted with a pressure-reducing nozzle *u* to prevent overloading of the gearing. If the low-pressure turbine is disabled, the exhaust from the high-pressure turbine *a* is by-passed to the condenser through a conduit *w* also fitted with a nozzle 1 to reduce the range of expansion in the turbine *a*. The astern turbines are fitted with similar conduits and nozzles. High-pressure steam may be supplied to an intermediate stage of the turbine *a* through a conduit *p* fitted with a nozzle *r* and a valve *q*. For closing the conduits not in operation, the ring flanges 5, Fig. 2, are replaced by blind flanges.

INDEX TO ADVERTISERS.

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CONTENTS.

EDITORIAL.

THE CONSERVATION OF BENZOLE.

WE have, on various occasions in this journal, advocated the taking of steps to prevent the output of benzole from falling into the hands of the petrol magnates. Something like 50,000,000 gallons per annum are being produced at a large number of centres in this country, and, although not sufficient in itself to upset the market in imported motor spirit, it is a very useful offset. Quite naturally, the petrol people would like to control all the supplies of motor fuel, however insignificant these may be, as they have never tolerated competition from any quarter. A strong agitation has developed in influential motoring and motor transport circles, with the object of securing that the benzole shall be conserved, and this appears to have had some effect upon the attitude of the producers. These people have met together, and have formed what is known as the National Benzole Association. The meeting at which the Association was inaugurated was held in London on February 12th, and was attended by quite a number of producers of crude and refined benzole. In the unavoidable absence of Mr. D. Milne Watson, governor of the Gaslight and Coke Company, the meeting was presided over by Mr. S. Henshaw, of the Staffordshire Chemical Company. In the brief statement that was made public after the meeting the objects of the Association were stated to include the standardising of benzole as a motor spirit, and carrying on investigation with a view to improving the suitability of benzole for motor or any other spirit.

Standard of Quality.

The first step taken by the new Association was the preparation of a specification of quality for motor spirit, which is as follows:—

1. Specific gravity, .870 to .885.
2. Distillation test (by flask): Benzole shall give a distillate of not less than 75 per cent to 80 per cent at 100 deg. Cen.; of not less than 90 per cent at 120 deg. Cen.; and of not less than 100 per cent at 125 deg. Cen.
3. Sulphur: The total sulphur shall not exceed 0.40 per cent.
4. The benzole shall be entirely free from water.
5. The colour shall be water white.
6. Rectification test: 90 cc. of the sample, shaken with 10 cc. of 90 per cent sulphuric acid for five minutes, should not give more than a light brown colour to the acid layer.
7. Benzole shall be entirely free from acids, alkalis, and sulphuretted hydrogen.
8. Benzole shall not freeze at 25 deg. Fah. below the freezing-point of water.

This specification shows that the Association were quick to appreciate the necessity of a technical standard for the motor trade, and motor transport users will, we have little doubt, welcome this step. They will most certainly expect further progress, so that they may get some relief, however slight, from the pressure of the oil octopus. For that reason we hope that the National Benzole Association will take into careful consideration the question of increasing the production of this commodity. There are many difficulties in the way, but if those who are in any respect concerned with industrial activities, such, for example, as the production of steel, will co-operate, the output of benzole may be substantially

increased. If the Government would only lend its aid much might be done to put this home-produced fuel on such a basis as to make it a great national asset. Fortunately, the distribution of benzole need not be a very difficult or costly affair, and already there is a sufficiently widespread and independent organisation for the purpose. The progress of the movement will be watched with interest not unmixed with anxiety, for we know only too well how subtle are the ways of the trusts, if they once make up their minds that a certain product stands between them and control of the entire field. "What cannot be wiped out must be bought out" is usually the maxim of these gentry, and that is one reason why we think a British Government should lend its aid to the conservation and protection of a British oil fuel, where its enemies are mostly foreigners.

Cheapness of Benzole.

Benzole is a cheaper commodity than petrol, but even if the increased demand for it were to force up the price to the equivalent of petrol we should still be the gainers, inasmuch as it is a home-produced article, and there is no necessity to export money, or its equivalent, in exchange for it. All this is to the good, and ought to be encouraged if we are ever going to free ourselves from being unduly dependent on sea-borne supplies. If this lesson has not been thoroughly learned, then the war, from a strictly commercial and economic point of view, has been altogether in vain. The National Debt, of course, makes it still more imperative that we should, as little as we can, and by increasing the production of benzole we are contributing directly to this desirable end. The National Benzole Association can undoubtedly do a very useful work, not only on the technical and commercial sides, but in stimulating public interest in the question. Its establishment comes not a moment too soon, for the removal of restrictions and the freedom of disposal would only give greater opportunities to those who are disposed to seek an alliance with the petrol ring on account of the good prices that might be got with little trouble.

MECHANICAL OPTIMISM.

It is generally conceded that every man is alternatively optimist and pessimist, seeing in turn no ray of light or else everything tinted with the colour of the rose. Whether any man can be permanently classed as either pessimist or optimist is open to grave doubt; yet, for many reasons, some incline naturally more to one side than the other.

It has been said that most virtues are vices in disguise, that, so far from optimism being a virtue, it is frequently an excuse for not facing realities. Contrary to accepted belief, the most pessimistic are frequently distinguished by their youth and optimism in a full sense appears often to be contemporary with the past-forty epoch of life.

Certain professions, indeed for that matter, every trade or calling, set their mark upon the practitioner in some manner or other. The mechanical engineering trade sets its sign manual like the rest; engineers, as a whole, like men of action generally, are in the main of an optimistic turn of mind. There is distinct pleasure in mechanical work, and activity of any order where results are seen is a sure antidote to melancholy.

The history of mechanical art is the history of the spirit of optimism. Difficulties which bristle at every turn exist to be surmounted. The present, as well as the past, teems with instances where the impossible has been made practicable, the overcoming of obstacles turns the most disgruntled into an optimist, and such instances are every-day occurrences in engineering work. Since optimism can only exist side by side with that personal belief in oneself, which is essential to successful conquest, every engineer must practice it, whether consciously or not. Lest, like Sunny Jim, he should exceed all bounds, it is not long before another apparent dead-end serves to moderate his exultation, and, brought face to face with fresh need, all his activity (a cure for pessimism) is called again into play.

Belief in himself, founded upon past experience, past conquests, tends to infect others, and there is literally no business where an optimistic spirit is more common. If progress in mechanical art is the outstanding feature of the past few decades, and the fact cannot be denied, then the virtue of optimism must be accorded its due share of recognition.

Whilst there are dangers latent in extravagant hope, easily realised upon a moment's reflection, there are more in unrestrained negation. There is too much tendency to belittle national achievement, introspection does not make for cheerfulness, and an attitude of pessimism seems fashionable, the truth is not so bad but that it has compensations.

Wild tales of omission and certain penalty have perhaps a substratum of truth, but while we cannot always keep smiling (quite an idiotic counsel, by the way), it is possible to maintain a sane, yet optimistic outlook. Some will always find a certain pleasure in being miserable, but it is a negative attitude; little yet ever came from despair; it is better to get busy, and so lose the spectre of shortcoming by aiding its removal. Seeing facts steadily, and seeing them whole, is one definition of sane outlook, and it is as well to grasp a hope rather than lose the substance by persistent want of belief.

There is always hope for the penitent, and past shortcomings are realised; the spirit of optimism breeds enterprise, and it is with cheerful mien, with courage and resource that the future is to be faced. Alternations of doubt and extravagant hope will not serve, the misgiving must be minimised for the hope to be realised. Will and vision support optimism, nothing is wholly lost while courage remains, and courage is both faith whose substance and evidence is unfaltering optimism.

The Frank Parmeler Express Co., of Chicago, which carries on a large business in transporting persons and luggage between railway stations and hotels, has for several months past been operating a storage battery 'bus for the purpose. The 'bus, the first of several, it is understood, has a seating capacity of 12 persons and also space for their baggage. Edison cells are used, and these have capacity for a daily run of 50 miles, with the 'bus fully loaded. The method of carrying the baggage is of special interest because of its ingenuity and compact arrangement. The 'bus was built by the Walker Electric Vehicle Co., and has been the subject of much favourable comment from passengers as well as the general public who have seen it travelling the streets so silently, smoothly, and without odour.

REINFORCED CONCRETE: THE "CLAUGHTON IDEAL" BEAM THEORY.

By James Claughton.

(Continued from Vol. VI., page 445.)

Reinforced Concrete Beams with Steel in Compression and in Tension.

The essential point to remember is this: always place the steel in the compression half of any reinforcep concrete beam on the same level as the centre of stress in the concrete. On the understanding that the above statement is rigidly adhered to, the following modifications only are required to the formulæ already given for use with simple beams:—

Let A_c = area of steel in compression.
„ t_c = compressive stress of steel.
„ c_2 = stress in concrete at level of centre of stress.

then $c_2 = \frac{2c}{3}$

but $t_c = mc_2$ XXXIII.

and $A_c t_c = A_c m c_2 = \frac{2}{3} cmA_c$

$M = \frac{cI}{n}$ IV. $M = \frac{tI}{m(d-n)}$ VI.

$$I = \left\{\frac{bn^3}{12} + \frac{bn^3}{4}\right\} + \left\{(m-1)A_c\left(\frac{2n}{3}\right)^2\right\} + \left\{mA_s(d-n)^2\right\}$$

$$= \frac{bn^3}{3} + \frac{4}{9}n^2A_c(m-1) + mA_s(d-n) \qquad \text{XXXIV. (VII. modified).}$$

$$\frac{bn^2}{2} + \frac{2cnA_c(m-1)}{3} = mA_s(d-n) \qquad \text{XXXV. (VIII. modified).}$$

$$n_1 = \frac{mc}{mc+t} \qquad \text{X.}$$

Total tension = total compression.

$$A_s t = \frac{c}{2}bn + (m-1)A_c\frac{2}{3}c.$$

$$\therefore A_c = \frac{tA_s - \frac{c}{2}bn}{\frac{2}{3}(m-1)c} \qquad \text{XXXVI.}$$

$$R_c = a\left\{\frac{c}{2}bn - \frac{2}{3}cA_c(m-1)\right\} \qquad \text{XXXVII. (XVIII. modified).}$$

$$= \frac{ac}{2}\left\{bn - \frac{4}{3}A_c(m-1)\right\}$$

$$R_s = A_s ta \qquad \text{XIX.}$$

$$A_s = \frac{M}{at}$$

Shear formulæ XXX., XXXI., and XXXII. apply to doubly reinforced beams, as well as for singly reinforced beams.

To many readers it will not be quite clear that

$$n_1 = \frac{mc}{mc+t}$$

for beams with steel in compression. The following mathematical deductions will prove the assertion to be correct:—

$n = n_1 d.$

$$\frac{bn^2}{2} + \frac{2}{3}cnA_c(m-1) = mA_s(d-n) \qquad \text{XXXV.}$$

$$A_c = \frac{tA_s - \frac{c}{2}bn}{\frac{2}{3}(m-1)c} \quad \text{multiply all the terms by } a \qquad \text{XXXVI.}$$

$$= \frac{tA_s a - \frac{c}{2}bna}{\frac{2}{3}(m-1)ca}$$

But $tA_s a = R_s = M$. XIX.

$$\therefore A_c = \frac{M - \frac{c}{2}bna}{\frac{2}{3}(m-1)ca}$$

and $A_s = \frac{M}{at}$

By substituting the above values for A_c and A_s in formula XXXV. we can solve for n as follows:—

$$\frac{bn^2}{2} + \left\{\frac{2}{3}(m-1)n\left(\frac{M - \frac{c}{2}bna}{\frac{2}{3}(m-1)ca}\right)\right\} = \frac{mM}{at}(d-n)$$

$$\frac{bn^2}{2} + \frac{n}{ca}\left(M - \frac{c}{2}bna\right) = \frac{mM}{at}(d-n).$$

$$\frac{bn^2}{2} + \frac{nM}{ca} - \frac{bn^2}{2} = \frac{mM}{at}(d-n)$$

$$\frac{nM}{ca} = \frac{mM}{at}(d-n)$$

$$\therefore n = \frac{mc}{t}(d-n)$$

$$= \frac{mcd}{t} - \frac{mcn}{t}$$

whence $n + \frac{mcn}{t} = \frac{mcd}{t}$

$$n\left(1 + \frac{mc}{t}\right) = \frac{mcd}{t}$$

$$n\left(\frac{t+mc}{t}\right) = \frac{mcd}{t}$$

$$\therefore n = \left(\frac{mc}{mc+t}\right)d$$

but $\frac{mc}{mc+t} = n_1$ $\therefore n = n_1 d$, which was to be proved.

This coincides with the formula or simple beams. From it we may deduct the following statement:—The neutral axis for any beam is fixed if we know c and t.

The foregoing proves that the position of the neutral axis does not change, providing that steel is added to both sides of the beam in the proportion required by the equation, that the total tension equals the tota' compression.

The above being correct, it follows that the arm of the force couple of the beam a remains the same. Likewise, given the depth of any beam it is possib!e by adding suitable reinforcement to increase its load-carrying capacity without increasing the required depth as given. It is useful to know this, especially in those cases where the depth is fixed; for instance, during alterations and repairs to existing buildings.

EXAMPLE I.—A simple beam of reinforced concrete is required to carry a uniformly distributed dead load of 3 tons over a span of 6 feet.

	Lbs.
(1) Actual load to be carried 3 tons =	6720
Assume weight of beam at 4 cwt. =	448
	7168 say 7200 lbs.

$$M = \frac{WL}{8} = 64800 \text{ inch-lbs.}$$

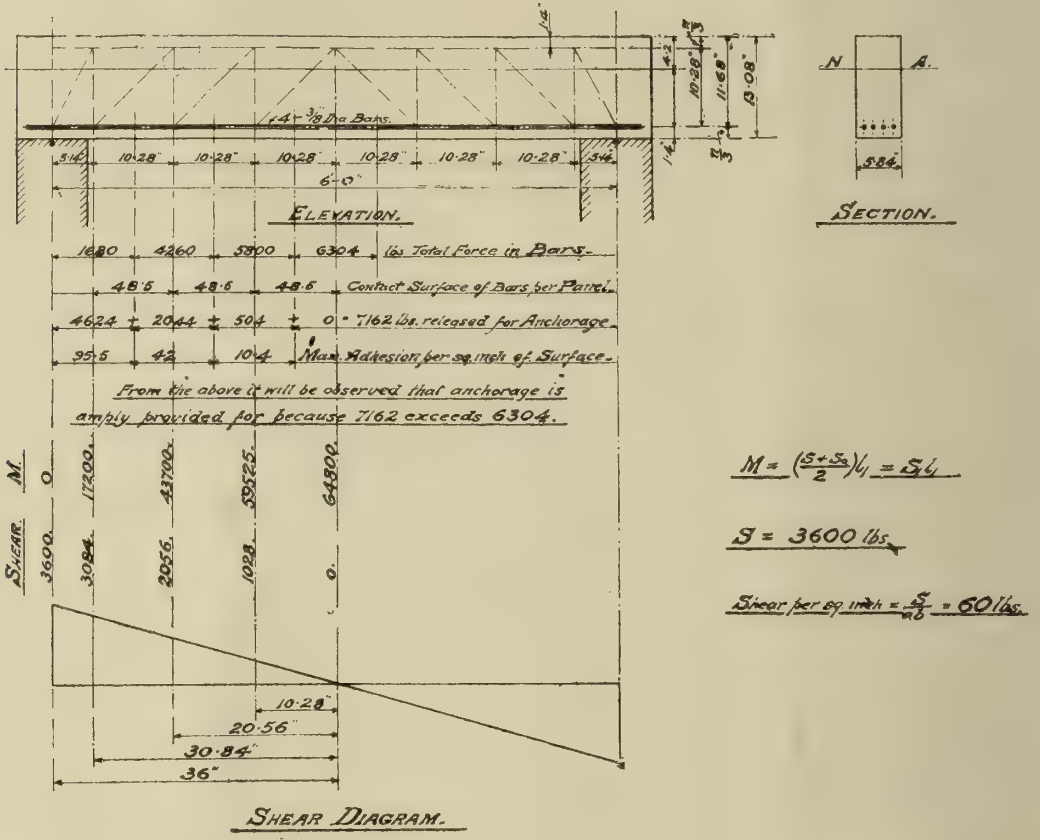
(6) The neutral axis $n = n_1 d = 4{\cdot}2048$ inches.

(7) Cross-sectional area of steel required is :—

$$A_s = \frac{M}{t\left(d - \frac{n}{3}\right)} = {\cdot}3940 \text{ square inches.}$$

(8) $a = \left(d - \frac{n}{3}\right) = 10{\cdot}2784$ inches.

(9) Number of panels $\frac{L}{a} = \frac{72}{10{\cdot}2784} = 7$ panels.



(2) Maximum shearing force = Reaction at suppports. or $S max = \frac{M}{l_x}$ where $l_x = \frac{L}{4}$. Thus, $S max = \frac{M \times 4}{L}$ $= 3600$ lbs.

(3) Tests give us the following values for the working stresses of concrete and steel :—$c = 600$ lbs., $t = 16000$ lbs., and $m = \frac{E_s}{E_c} = 15$.

$$n_1 = \frac{mc}{mc + t} = {\cdot}36$$

(4) Let $b = \omega d$, if $\omega = {\cdot}5$

then $d = \sqrt{\frac{S}{{\cdot}5 c_1 \left(1 - \frac{n_1}{3}\right)}}$ as stirrups will not be used $c_1 = 60$ lbs. per sq. in. L. C. C. Reg.

$d = 11{\cdot}68$ inches.

(5) $\frac{\text{Span}}{\text{Depth}} = \frac{72}{11{\cdot}68} = 6{\cdot}16$; therefore deflection will be quite negligible. *See* verification for this statement.

(10) *See* diagram for sheer stress.

The calculations are now complete except for verification, as follows :—

$c = \frac{M \times 2}{bna} = 513{\cdot}5$ lbs. This value is therefore the maximum stress in the concrete.

(To be continued.)

THE INFLUENCE OF IMPURITIES ON THE MECHANICAL PROPERTIES OF ADMIRALTY GUN-METAL.

By F. JOHNSON, M.Sc., BIRMINGHAM.

(Continued from page 206.)

IN Table III. are given the results obtained by H. S. Primrose from adding lead to gun-metal. In each case the lead displaces its equivalent weight of copper. Gun-metal of Admiralty type containing lead is often used as a bearing metal. The presence

of lead lowers the rate of wear, but increases the friction coefficient.

Primrose states that the bearing is not so reliable when the lead is in large particles and irregularly distributed as when it is in small, well-distributed particles. He states that when lead is added to a zinc-free bronze, a tin-lead eutectic separates out, but he offers no evidence in support of this claim.

Table III.

Mark.	Lead per cent.	Tensile Stress. Tons per Sq. In.	Elongation per cent.	Brinell Hardness.	Melting Point. Deg. C.
..		18·6	18·4	70	998
A	0·5	17·4	16·8	65	965
B	1·5	15·3	17 1	60	920
C	3·0	14 9	12·5	55	870

Iron.

None of the above-mentioned investigators have a good word to say for the presence of iron in Admiralty gun-metal. Dewrance and Philip state that a hard iron-tin constituent is formed. Primrose confirms this, and states that this constituent makes its appearance "in the delta constituent" with as little as 0.11 to 0.15 per cent. The effect of this constituent is not determinable until the iron has reached 0.3 per cent, whilst the effects of 0.6 to 1 per cent are very harmful. Gulick states that iron raises the tensile strength and lowers the elongation.

Manganese.

Gulick states that manganese acts as a deoxidiser and increases the soundness, tensile strength, and toughness of bronze castings, whilst reducing the elongation only slightly.

Nickel.

Little is known about the influence of nickel. Dewrance does not favour its addition owing to its alleged action of liberating occluded gas during cooling of the casting, thus causing porosity.

G. A. Boeddicker, in the discussion on Dewrance's paper, rightly points out that if added as cupro-nickel (50-50) it does not require so high a temperature for its liquefaction, thus obviating the risk of overheating the bronze.

Gulick attributes to nickel a beneficial influence in aiding to form a dense, close-grained structure, and in lowering the rate of wear.

Silicon.

The employment of silicon as a deoxidising agent in preference to phosphorus for bronze required to be used for electrical purposes is old. In Table IV. it

Table IV.—(*Guillet's Experiments*).

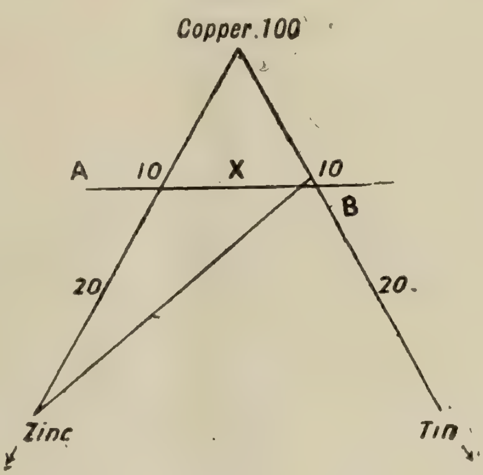
Composition.				Added Impurity.	Condition.	Ultimate Tensile Stress. Tons per Sq. In.	Elongation per cent.
Copper per cent.	Tin per cent.	Zinc per cent.	Lead per cent.				
89·0	9·0	1·5	0·5	nil	cast	18	24
89 0	9·0	1·5	0·5	trace P	,,	20	41
89·0	9·0	1·5	0·5	0·13 P	..	18	19
89·0	9·0	1·5	0·5	trace Si	,,	17·2	20
89·0	9·0	1·5	0·5	trace Al	..	19·4	43
90·0	10·0	..	..	trace P	rolled and annealed	25·0	67

will be seen that, according to Guillet, a small amount of silicon as a deoxidiser does not improve the mechanical properties of zinc-bonze.

J. S. G. Primrose, in the discussion on Dewrance's paper, objects to the presence of even a small proportion of silicon, owing to its hardening effect both at normal and at high temperatures. He considers that silicon can be taken up by gun-metal which has been melted under a flux of glass.

Zinc.

As the author is dealing with the influence of minute quantities of elements on an alloy containing 2 per cent of zinc, this metal need not be considered. It is well known that beyond 2 per cent no advantage is to be gained, and, in fact, further additions of zinc result in deterioration. He would, however, refer briefly to the work of Guillet and Révillon, who endeavoured to work out the "coefficient of equivalence" of zinc when added to bronze. In a given sample of bronze, in which zinc has been introduced at the expense of tin, the zinc may be determined by chemical analysis, giving the real figure. But by microscopic examination it is found



that the amount of *a* present is *more* than is found in a zinc-free bronze of similar tin content. In view of the author's experience and of the work of L. Hoyt, these statements are difficult of acceptance.

If Hoyt's ternary diagram be studied, it will be found that, maintaining the proportion of copper constant, so soon as the composition of the alloy is changed by substituting zinc for tin, the ternary alpha + eutectoid phase field is being traversed towards the ternary alpha phase field, and when sufficient zinc has been substituted for tin, the alpha + eutectoid field is left behind, and the alloy consists entirely of alpha. This may readily be followed from a glance at the diagram. Any point on AB represents an alloy of the same copper content, say 88 per cent. At the point B the alloy is 88 per cent copper, 12 per cent tin, and the constitution is alpha + eutectoid. Travelling along the line towards A, the eutectoid *diminishes* in quantity, and with an alloy consisting of, say, 88 per cent copper, 6 per cent zinc, and 6 per cent tin, the constitution is all alpha. (Point X.)

The findings of Guillet and Révillon are therefore incompatible with the constitutional diagram, and

their formula is apparently based on a misconception. The formula is as follows :

$$Cf = 1 + \frac{(A - A')\,100}{qA'}$$

in which A = actual percentage of copper.
A′ = fictitious percentage of copper.
q = amount of zinc found by analysis.

(*To be continued.*)

DRAWING OFFICE SYSTEMS AND MANAGEMENT.

By M. Coronel.

(*Concluded from page 207.*)

The Order and Drawings Department.

Every modern engineering works has nowadays a separate staff of technically-trained clerks who have had either shop or drawing-office experience. When the tracings come from the checker and have been passed by the chief draughtsman and engineer in charge they should be handed over to the order department, which will write out a drawings list comprising all drawings and parts wanted for one order. In other words, each order should have its own drawing list or lists. These are written or printed on thin white bond paper so as to be able to get blue prints from them. After these lists have been written out, giving drawing numbers, material of parts, how many required off, and by which department to be made, together with any further explanatory remarks for the guidance of the shops, the order department will order the necessary blue prints of drawings and drawing lists to be issued to the shops.

Any further particulars regarding the issue of prints for the shops or outside customers should be transacted by the order department. When changes to drawings are to be made they should also go through the order department, although actually changed by the draughtsman, so that the order department is kept in touch with any change in material, quantities, or cancellations.

Changing Drawings and Recalling Them from the Shops.

If drawings have to be changed after being issued to the shops, additions or cancellations made on them, a card or note on a printed form should be issued by the draughtsman to the order department, to get the drawings from the shops and deliver them to him. After receiving these drawings, the original tracing and any office file copies should be got from the stores, and the alterations, etc., made on all copies, a note as to what the alteration consists of to be made in a small space left for this purpose on the bottom border line of the drawing (see under previous article, Fig. 3). This alteration should be initialled and dated by the draughtsman, and all alterations should be given a consecutive number. For guidance and record in the order office a slip or card should be attached to the drawings repeating the nature, date, and cause of change. After taking and filing these particulars the order office re-issues the drawings to the shops.

When the jobs are finished, all workshop drawings should be recalled from the shops and either be filed away or destroyed. It is a good plan to glue all workshop drawings on strong cardboard, as it prolongs their life and they are not liable to get torn. Blue prints on cloth, rolled up on wooden rollers, are sometimes used, but do not give such satisfactory results. The cardboard can be used over and over again by pasting other drawings on top of the drawings of jobs finished in the shops.

Position of Drawing Office.

The drawing office should, if possible, be rectangular in shape. One of the longer sides should face north and have all windows on that side, and be situated on a floor high enough to give an uninterrupted view over any surrounding buildings,

TO WORKS MANAGER — SHEET. No 1.
MANUFACTURING INFORMATION FOR ENGINE No 376.S
DATE 9.IV.18 — SIZE 20″+20″×40″

NAME OF DRAWING	DRG. No	REQ	DATE ISSUED
STEAM CYLINDER	A 4521	2	14/1/18
FRONT CYL. COVER	A 4610	2	18/4/18
BACK CYL. COVER	A 4510	2	28/12/17
INLET CORLISS VALVE.	B 4421	4	18/11/17
EXHAUST CORLISS VALVE	B 4420	4	18/11/17
PISTON & ROD	A 4571	2	19/1/18
CONNECTING ROD & BRASSES	C 4110	2	1/11/17

ENGINE No 376 — ISSUED BY CHIEF DRAUGHTSMAN J. Johnson.

Fig. 13.

so as to get a good light and catch the longest and most even light all day.

The boards should be placed in rows at right angles to this wall, and in such a manner that the drawing gets the light on the left-hand side. As regards the position of the drawing office in relation to the shops, it should be isolated and far enough from the noise in the shops so as to present a quiet and congenial atmosphere, as there is no more disturbing factor in a drawing office, conducive to brain weariness, than the continuous noise and jar due to the proximity of machinery. On the other hand, the drawing office should be as near as convenient to the pattern shop as this is, in the first place, the shop with which the drawing office has to deal most frequently in consultation with the pattern foreman

over moulding difficulties and other matters of progress of work.

For easy communication with the various other shops there should be throughout the offices and shops a system of inter-telephones with or without an exchange, which latter is only necessary in large works, so that the drawing office can speak with the various foremen without having to go the distance separating them.

Lighting.

The matter of artificial lighting during the winter months is of the greatest importance for the well-being of the office staff, as well as for the efficiency and amount of work turned out from the office. Although most offices have now introduced electric light, the form of such light is very different. The individual old-fashioned 16 candle-power carbon filament lamps are the worst in this respect, 32 or 50 candle-power metal filament lamps are better, but the ideal light for a drawing office is the indirect reflected light, thrown on to a white ceiling by a series of powerful arc-lamps. The mercury-vapour lamps are also said to give very good results, and an even and soft light.

Heating and Ventilation.

This is also a very important question, and a problem on which, in most works and drawing offices, not enough forethought has been spent. The main points in an efficient and reliable heating and ventilating system are that it can be regulated from a good supply of cold, fresh air on hot days without creating any draught, to a good and comfortable supply of heat on cold days without making the office close and stuffy, and at the same time allowing for a sufficient supply of fresh air to enter and the foul air to leave the office. It must be known to every experienced draughtsman that a cold office is only conducive to standing about with one's hands anywhere but at the drawing board. On the other hand, a too hot and stuffy office often turns it into an after-dinner rest room.

In Conclusion.

It should be noted that although in these articles not much stress has been laid on the use of efficient and different kinds of card index systems, this is considered of vital importance. It should be pointed out that not enough stress can be laid on the use of such card indexes. It has already been mentioned in connection with the drawing index, but the chief draughtsman should keep an index of the progress of work on each job, entering up which drawings have been given for execution to each draughtsman, with the dates of starting and finishing. The checker or assistant chief should keep an index as to the progress of each drawing of each job in its various stages, so that the manager can get, at any time, the information from the drawing office as to where and when he can expect to get a certain drawing.

An index as to where to purchase outside material and latest prices should be kept. An index of all standards used in the drawing office and various indexes should be kept by the order department as to when drawings are sent out, material ordered, and drawings recalled from the shops, etc., etc.

The author hopes that he has given to many, especially the younger readers, information which may be of use to them in the near future, although the data stated here may be common knowledge to many of the experienced men. The course indicated is only one out of many at present in use in drawing offices run or equipped on modern lines.

In conclusion, the author wishes to point out that an efficient system is of great advantage in any drawing office, large or small, but a word of warning is given that one should not overdo a system and strangle oneself with the running of the drawing office, in following too strictly a system once decided upon. Common sense, as everywhere else, is a great help also here.

(Concluded.)

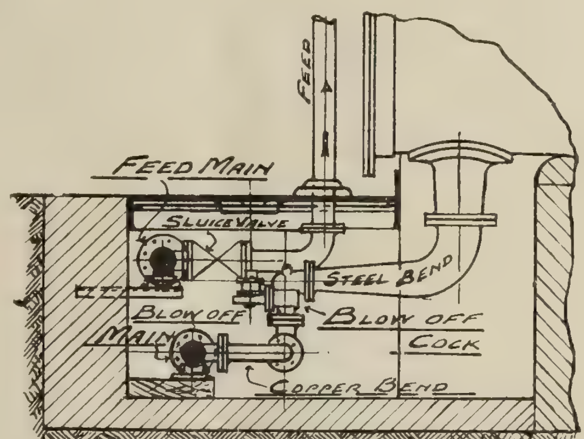
ENGINEERING LAY-OUT ARRANGEMENTS AND TENDER DRAWINGS.

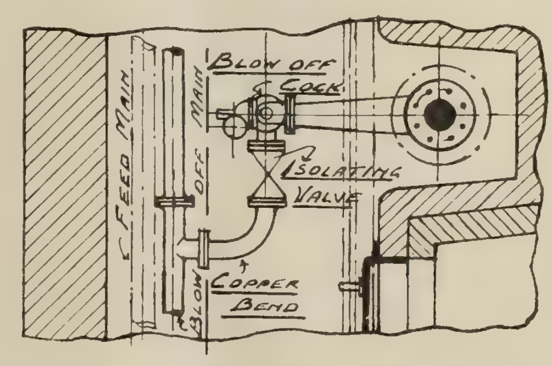
By Douglas Wilson, A.M.I.Mech.E.

(Continued from page 213.)

The Feed Piping.

The delivery piping from boiler feed pumps should always be of the same material as the main steam pipes, as, of course, it will be subjected to the same





Engineering Lay-out.—Figs. 59 and 60.

pressure. The same obviously applies to the injector delivery pipes, these usually being very short connections.

Sharp bends must be avoided in the line, and the pumps should be as close as practically convenient to the boilers so as to keep the piping as short and direct as possible, thereby reducing pipe friction,

radiation losses, and cost. The piping, like the main steam piping, must be covered, assuming that a feed water heater or economiser is installed. The practice of delivering cold water to the boiler is not a good one, as it causes unequal expansion and contraction of the plates. If the water is taken from a hot well at about 90 deg. to 100 deg. Fah. or lower, it is not wasting money lagging the piping.

The feed main to, say, a range of Lancashire boilers, may be fixed overhead as shown in Figs. 57 and 58, or in the blow-off trench as shown in Figs. 59 and 60, whichever is more convenient. Perhaps it may be found cheaper and more direct to take the feed overhead, where economisers are used, as the hot water outlet connection is at the top of the economiser pipes some 10 or 11 feet above floor level. Where feed water heaters are used it may be more advisable to place the feed main in the blow-off trench as the hot water outlet is generally near the floor level, in the ordinary type of feed water heater The main is out of the way, and certainly gives the boiler house a better appearance..

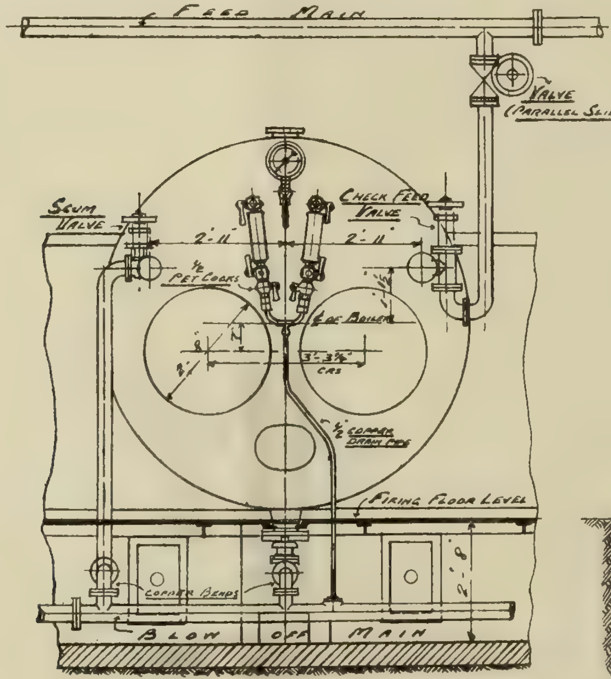


Fig. 57.

Engineering Lay-out.

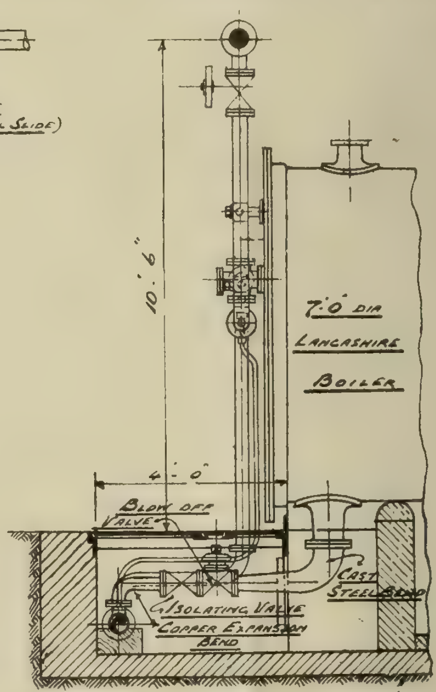


Fig. 58.

Check Sluice Valves.

Referring to Figs. 57 and 58, the sluice valve in the vertical branch pipe from the feed main is always to be advocated, in case it should be necessary to examine or repair the check feed valve whilst the boiler is under steam, otherwise it would not be possible without stopping the feed pump, and uncoupling the piping, etc.

As regards the choice of check and sluice valves, these are generally specified, but if they are not, the importance of installing good makes cannot be overestimated. Most boiler makers, unless called for otherwise, include in their specifications for all fittings, valves, cocks, gauges, etc., but it is not always easy to find out whose make they are. The writer recommends the fittings of Messrs. Hopkinson, Dewrance and Turnbull as being thoroughly reliable. There are other good makers, but the above are familiar to the author, who has found them very much called for.

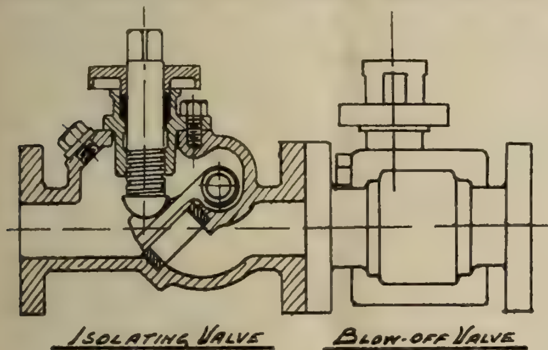
When the feed is carried in the blow-off trench the sluice valve may be fixed in the position shown, and can be opened or closed by means of an extended spindle or box key.

The Blow-off Connections, etc.

The blow-off main in the boiler house is generally conveyed to a drain, unless a canal or river is near, the latter being more satisfactory than turning the hot water into the drain. Where the water is bad it is the practice of some firemen to open the blow-off cock during the day for short intervals. In this case it is better to take the blow-off main into the canal, river, or sump, and not into a drain, as the velocity of the water would soon have a bad effect on the drain pipes. A boiler should not be blown off whilst pressure is up. This should be brought down very low, and cold water must not be pumped in afterwards to reduce the temperature. The pipes for the blow-off main can be made of cast-iron, and may simply rest on timber blocks in the blow-off trench, or better still, on cast-iron rollers as shown in Fig. 59.

The most modern arrangements of blow-off valves and connections are shown in Figs. 57, 58, 59 and 60. An isolating valve is recommended where two or more boilers in battery are connected to a common main, this preventing any accidents should the blow-off cock of an empty or stand-by boiler be left open whilst one of the group is being blown off, and men are working in the empty boiler. The blow-off and isolating valves must be connected with a flexible bend to the main as shown, a copper bend being commonly adopted for this. The cast-steel elbow pipe for attachment to the blow-off cock is

nearly always supplied with the boiler by the makers, though most of the steam fittings manufacturers have these listed in their catalogues, also the copper bends. The blow-off arrangement shown in Figs. 59 and 60 is a very good one, ample room is available for access to the valves, and the connection to the main very elastic. The blow-off valve is of the angle pattern, bringing the main low down and making room in the trench for the feed main. An additional steel bend is required for this arrangement, which adds to the cost in comparison with the straight lay arrangement, as shown in Figs. 57 and 58. The drain pipe from the heater gauges should be taken into the blow-off main. This pipe is often of polished copper, which makes the best job. The scum valve outlet pipe is connected to the main, and, like the blow-off valve, should be coupled up by means of a copper bend, this also holding good for the feed



Engineering Lay-out.—Fig. 61.

connection when the feed main is in the blow-off trench (Figs. 59 and 60). Fig. 61 shows a combined arrangement of blow-off valve and isolating valve with regulation screw. By this means the latter can be opened to blow off or closed when required, whilst the blow-off valve remains open full. By this method the fluid tightness of the blow-off valve is preserved, and where asbestos-packed cocks are used it is really necessary. Most engineers now embody this combination in their specifications.

The writer strongly advises the use of the rack and pinion type of blow-off cock in lieu of the asbestos-packed type, as there is no danger of the former sticking as the latter often does.

(To be continued.)

GOVERNORS AND GOVERNING MECHANISM.

By A. Houlson.

(Continued from page 209.)

Hartnell Gear.

The well-known Hartnell expansion gear is shown in Fig. 48, and in Fig. 49 a perspective view of same is given. The valve diagram is shown in Fig. 50. The crank is supposed to start at A and the direction of rotation is shown by the arrow.

Valve Diagram.

In problems of this kind the main valve is assumed to be stationary, the expansion valve sliding over it as if it were a fixed face.

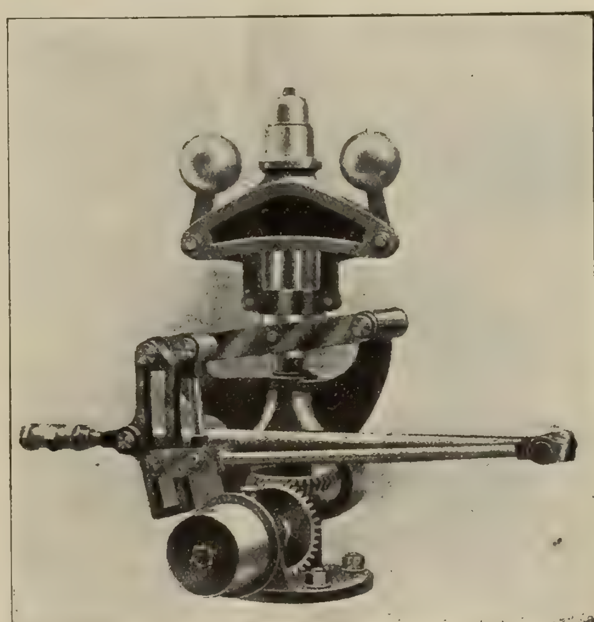
The throw and angle of advance of an eccentric, which, under such conditions, would give to the expansion valve the same relative movement to the main valve that it has in actual working, is found as follows:—Let O M be the main eccentric, and θ_1 its angle of advance; O E the expansion eccentric at mean travel for normal speed; θ_2 its angle of advance.

In Fig. 50 draw O Y parallel and equal to M E. Then O Y is the throw and position of the virtual eccentric. Produce O Y to Y, then the relative travel circles may be drawn as shown in Fig. 51.

The Zeuner circles are drawn for the main valve in the usual manner, and the points of admission and cut-off obtained from the interception of these circles with the lap are struck with radius O L = lap of main valve. The points of release and compression are also obtained by drawing the arc with radius O Q = positive exhaust lap on main valve.

On the same diagram Fig. 50 is drawn the relative travel circle for the smallest throw of the expansion eccentric.

Draw an arc with radius O N = n the negative lap on expansion valve (see Fig. 52). The inter-



Governors.—Fig. 49.

ception of the top relative travel circle with the negative lap circle of radius O N gives the re-opening at earliest cut-off, which should occur after the closure of the main valve. The port opening at normal speed is set out as follows, the expansion eccentric being at E.

Divide the arc A B of the main valve travel circle into six equal parts. Radial lines drawn through the points of division give the crank angles 0 deg. to 120 deg. as shown.

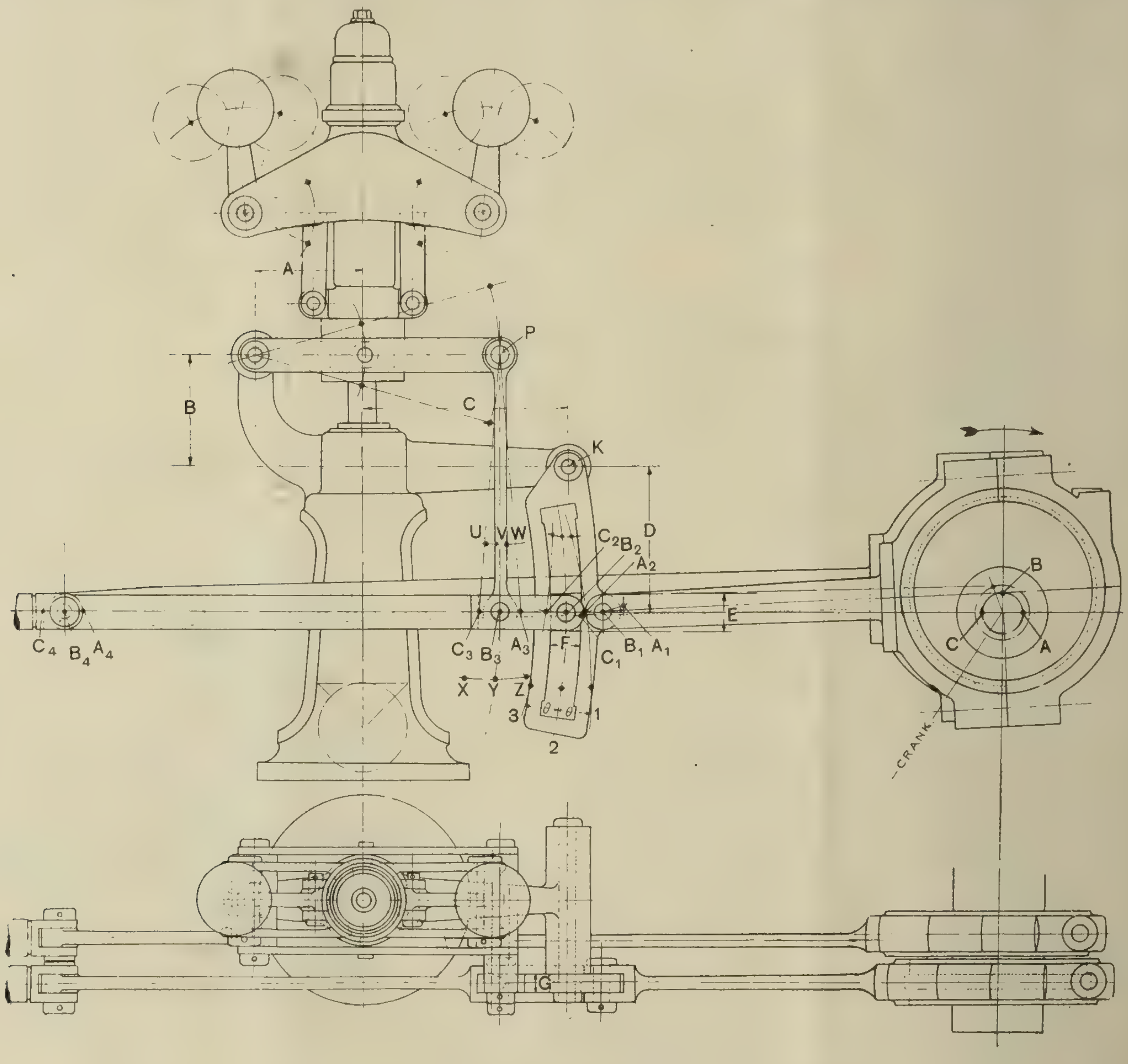
The admission takes place generally a few degrees before the dead point.

At a convenient distance below the diagram set

out a base line C D (Fig. 54), and on this base line erect ordinates 0 deg. to 120 deg., the distance between each ordinate being equal to the corresponding arc on the travel circle A B. Draw a line parallel to the base line, and at a distance above it equal to the main lap O L. Take each of the radial intercepts O T, O M, etc. (Fig. 50), corresponding to the different angles, and erect them as ordinates on the base line as shown. The area enclosed between the lap line and the curve thus found gives the expansion valve has moved to the right of the centre of the main valve at that particular position of the crank.

Similarly, the radial intercepts of the polar circle O Y_1 represent the distances that the centre of the expansion valve has moved to the left of the centre of the main valve.

It will now be clearly seen that at the dead point the outer slot S in the main valve is full open, the expansion valve being a little further to the right



Governors.—Fig. 48.

the port opening past the edges of the main valve into the cylinder.

On the diagram Fig. 51 draw a line O X at right angles to O Y. O X is the crank angle when the expansion valve is in its "mid" position over the main valve as shown in Fig. 52. The centres of the main and of the expansion valve coincide when the crank is in the position O X. As mentioned before, in problems of this kind the main valve is supposed to be stationary and the expansion valve is supposed to slide over it as if it were a fixed face. Then, any radial intercept such as r_1 of the polar circle O Y (Fig. 51) represents the distance that the centre of than shown in Fig. 52, and that it will remain full open until the crank position O X, when the expansion valve comes back to the position shown in Fig. 52.

From O X to the point of cut-off O F the outer slot S gradually closes until at O F when the travel to the left is equal to distance n (Fig. 52) it is closed entirely. This may be set out downwards from the base line in the diagram (Fig. 54) as shown by the line K.

Considering now the inner slot R. At the dead point the expansion valve has moved so much to the right (see Fig. 53) that the slot R would be partially

Weights of Lengths of Rolled Steel Sections.

Beam $4\frac{3}{4}$ in. × $1\frac{3}{4}$ in. × 7·5 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	Ft.
0	..	0 2 19·0	1 1 10·0	2 0 1·0	2 2 20·0	3 1 11·0	4 0 2·0	4 2 21·0	5 1 12·0	6 0 3·0	0
1	0 0 7·5	0 2 26·5	1 1 17·5	2 0 8·5	2 2 27·5	3 1 18·5	4 0 9·5	4 3 0·5	5 1 19·5	6 0 10·5	1
2	0 0 15·0	0 3 6·0	1 1 25·0	2 0 16·0	2 3 7·0	3 1 26·0	4 0 17·0	4 3 8·0	5 1 27·0	6 0 18·0	2
3	0 0 22·5	0 3 13·5	1 2 4·5	2 0 23·5	2 3 14·5	3 2 5·5	4 0 24·5	4 3 15·5	5 2 6·5	6 0 25·5	3
4	0 1 2·0	0 3 21·0	1 2 12·0	2 1 3·0	2 3 22·0	3 2 13·0	4 1 4·0	4 3 23·0	5 2 14·0	6 1 5·0	4
5	0 1 9·5	1 0 0·5	1 2 19·5	2 1 10·5	3 0 1·5	3 2 20·5	4 1 11·5	5 0 2·5	5 2 21·5	6 1 12·5	5
6	0 1 17·0	1 0 3·0	1 2 27·0	2 1 18·0	3 0 9·0	3 3 0·0	4 1 19·0	5 0 10·0	5 3 1·0	6 1 20·0	6
7	0 1 24·5	1 0 15·5	1 3 6·5	2 1 25·5	3 0 16·5	3 3 7·5	4 1 26·5	5 0 17·5	5 3 8·5	6 1 27·5	7
8	0 2 4·0	1 0 23·0	1 3 14·0	2 2 5·0	3 0 24·0	3 3 15·0	4 2 6·0	5 0 25·0	5 3 16·0	6 2 7·0	8
9	0 2 11·5	1 1 2·5	1 3 21·5	2 2 12·5	3 1 3·5	3 3 22·5	4 2 13·5	5 1 4·5	5 3 23·5	6 2 14·5	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	0 ·625	0 1·25	0 1·875	0 2·5	0 3·125	0 3·75	0 4·375	0 5·0	5·625	0 6·25	0 6·875	0 7·5	

Weights of Lengths of Rolled Steel Sections.

Beam $4\frac{3}{4}$ in. × $1\frac{3}{4}$ in. × 7·5 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	6 2 22	13 1 16	1 0 0 10	1 6 3 4	1 13 1 26	2 0 0 20	2 6 3 14	2 13 2 8	3 0 1 2	0
10	0 2 19	7 1 13	14 0 7	1 0 3 1	1 7 1 23	1 14 0 17	2 0 3 11	2 7 2 5	2 14 0 27	3 0 3 21	10
20	1 1 10	8 0 4	14 2 26	1 1 1 20	1 8 0 14	1 14 3 8	2 1 2 2	2 8 0 24	2 14 3 18	3 1 2 12	20
30	2 1 1	8 2 23	15 1 17	1 2 0 11	1 8 3 5	1 15 1 27	2 2 0 21	2 8 3 15	2 15 2 9	3 2 1 3	30
40	2 2 20	9 1 14	16 0 8	1 2 3 2	1 9 1 24	1 16 0 18	2 2 3 12	2 9 2 6	2 16 1 0	3 2 3 22	40
50	3 1 11	10 0 5	16 2 27	1 3 1 21	1 10 0 15	1 16 3 9	2 3 2 3	2 10 0 25	2 16 3 19	3 3 2 13	50
60	4 0 2	10 2 24	17 1 13	1 4 0 12	1 10 3 6	1 17 2 0	2 4 0 22	2 10 3 16	2 17 2 10	3 4 1 4	60
70	4 2 21	11 1 15	18 0 9	1 4 3 3	1 11 1 25	1 18 0 19	2 4 3 13	2 11 2 7	2 18 1 1	3 4 3 23	70
80	5 1 12	12 0 6	18 3 0	1 5 1 22	1 12 0 16	1 18 3 10	2 5 2 4	2 12 0 26	2 18 3 20	3 5 2 14	80
90	6 0 3	12 2 25	19 1 19	1 6 0 13	1 12 3 7	1 19 2 1	2 6 0 23	2 12 3 17	2 19 2 11	3 6 1 5	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs	Weight.
	3 6 3 24	6 13 3 20	10 0 3 16	13 7 3 12	16 14 3 8	20 1 3 4	23 8 3 0	26 15 2 24	30 2 2 20	33 9 2 16	

Compiled and Arranged by T. E. Woodhouse

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 5 in. × 2 in. × 9 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	Ft.
0	..	0 3 6	1 2 12	2 1 18	3 0 24	4 0 2	4 3 8	5 2 14	6 1 20	7 0 26	0
1	0 0 9	0 3 15	1 2 21	2 1 27	3 1 5	4 0 11	4 3 17	5 2 23	6 2 1	7 1 7	1
2	0 0 18	0 3 24	1 3 2	2 2 8	3 1 14	4 0 20	4 3 26	5 3 4	6 2 10	7 1 16	2
3	0 0 27	1 0 5	1 3 11	2 2 17	3 1 23	4 1 1	5 0 7	5 3 13	6 2 19	7 1 25	3
4	0 1 8	1 0 14	1 3 20	2 2 26	3 2 4	4 1 10	5 0 16	5 3 22	6 3 0	7 2 6	4
5	0 1 17	1 0 23	2 0 1	2 3 7	3 2 13	4 1 19	5 0 25	6 0 3	6 3 9	7 2 15	5
6	0 1 26	1 1 4	2 0 10	2 3 16	3 2 22	4 2 0	5 1 6	6 0 12	6 3 18	7 2 24	6
7	0 2 7	1 1 13	2 0 19	2 3 25	3 3 3	4 2 9	5 1 15	6 0 21	6 3 27	7 3 5	7
8	0 2 16	1 1 22	2 1 0	3 0 6	3 3 12	4 2 18	5 1 24	6 1 2	7 0 8	7 3 14	8
9	0 2 25	1 2 3	2 1 9	3 0 15	3 3 21	4 2 27	5 2 5	6 1 11	7 0 17	7 3 23	9

Weight of Beam, advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight.	lbs. 0·75	lbs. 1·5	lbs. 2·25	lbs. 3	lbs. 3·75	lbs. 4·5	lbs. 5·25	lbs. 6·0	lbs. 6·75	lbs. 7·5	lbs. 8·25	lbs. 9	Weight.

Weights of Lengths of Rolled Steel Sections.

Beam 5 in. × 2 in. × 9 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	8 0 4	0 16 0 8	1 4 0 12	1 12 0 16	2 0 0 20	2 8 0 24	2 16 1 0	3 4 1 4	3 12 1 8	0
10	0 3 6	8 3 10	0 16 3 14	1 4 3 18	1 12 3 22	2 0 3 26	2 9 0 2	2 17 0 6	3 5 0 10	3 13 0 14	10
20	1 2 12	9 2 16	0 17 2 20	1 5 2 24	1 13 3 0	2 1 3 4	2 9 3 8	2 17 3 12	3 5 3 16	3 13 3 20	20
30	2 1 18	10 1 22	0 18 1 26	1 6 2 2	1 14 2 6	2 2 2 10	2 10 2 14	2 18 2 18	3 6 2 22	3 14 2 26	30
40	3 0 24	11 1 0	0 19 1 4	1 7 1 8	1 15 1 12	2 3 1 16	2 11 1 20	2 19 1 24	3 7 2 0	3 15 2 4	40
50	4 0 2	12 0 6	1 0 0 10	1 8 0 14	1 16 0 18	2 4 0 22	2 12 0 26	3 0 1 2	3 8 1 6	3 16 1 10	50
60	4 3 8	12 3 12	1 0 3 16	1 8 3 20	1 16 3 24	2 5 0 0	2 13 0 4	3 1 0 8	3 9 0 12	3 17 0 16	60
70	5 2 14	13 2 18	1 1 2 22	1 9 2 26	1 17 3 2	2 5 3 6	2 13 3 10	3 1 3 14	3 9 3 18	3 17 3 22	70
80	6 1 24	14 1 24	1 2 2 0	1 10 2 4	1 18 2 8	2 6 2 12	2 14 2 16	3 2 2 20	3 10 2 24	3 18 3 0	80
90	7 0 26	15 1 2	1 3 1 6	1 11 1 10	1 19 1 14	2 7 1 18	2 15 1 22	3 3 1 26	3 11 2 2	3 19 2 6	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	4 0 1 12	8 0 2 24	12 1 0 8	16 1 1 20	20 1 3 4	24 2 0 16	28 2 2 0	32 2 3 12	36 3 0 24	40 3 2 8	

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Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

ENGINEERING APPOINTMENTS OPEN.

PERSONAL NOTES.

Mr. H. Booth, Carr Mills, Meanwood Road, Leeds, has taken a partner, and will in future trade under the style of **Messrs. Booth, Powell and Co.** The firm specialises in mild-steel tanks, rectangular or circular, welded, riveted, black or galvanized; containers, receivers, etc.

Messrs. Sir W. G. Armstrong, Whitworth and Co. Ltd. are now reorganising all the departments of their various works, with a view to undertaking a wide range of commercial engineering products, and assisting thereby to meet the requirements of the engineering industry, both at home and abroad, in connection with industrial reconstruction. The company has formed a Central Commercial Department, with headquarters at 8, Great George Street, Westminster, London. This department will control all matters relating to publicity and the commercial handling of the engineering products manufactured by the various departments of the concern. This department will apparently act as a central selling agency for the undertaking.

TRADE NOTES.

Messrs. James Marmon and Son Ltd., engineers' and ship repairers' merchants, 45, Regent Road, Liverpool, have added to their business an engineering and ship repairing supplies department.

The Brightside Foundry and Engineering Co. Ltd., heating and ventilating engineers, of Sheffield, London and Birmingham, have opened a West of England branch of this business at State Insurance Buildings, 14, Dale Street, Liverpool.

The Dowson and Mason Gas Plant Co. Ltd., Levenshulme, Manchester, has received an order for a 70 ft. "Weardale" angle air furnace, from Vickers Ltd., Barrow-in-Furness. Two similar furnaces were installed in 1910, and this is a repeat order.

The Glasgow Corporation Electricity Department has recommended acceptance of an offer by Messrs. Dick, Kerr and Co. Ltd. to supply for £133,736 a turbo-alternator condensing plant and transformer for the new generating station at Dalmarnock.

In discussing the paper on lubrication, read before the Physical Society by Principal S. Skinner, Mr. C. T. Thomsen said that it had been found that among mineral oils the best lubricants were those with a large proportion of unsaturated hydrocarbons. It is thought that the more of these that are present, the more intimately the oil will adhere to a metallic surface. Now some of the animal and vegetable oils are very largely composed of unsaturated constituents, so that this property of adherence to metallic surfaces may readily be greater in these cases. He thought compressibility was of negligible importance.

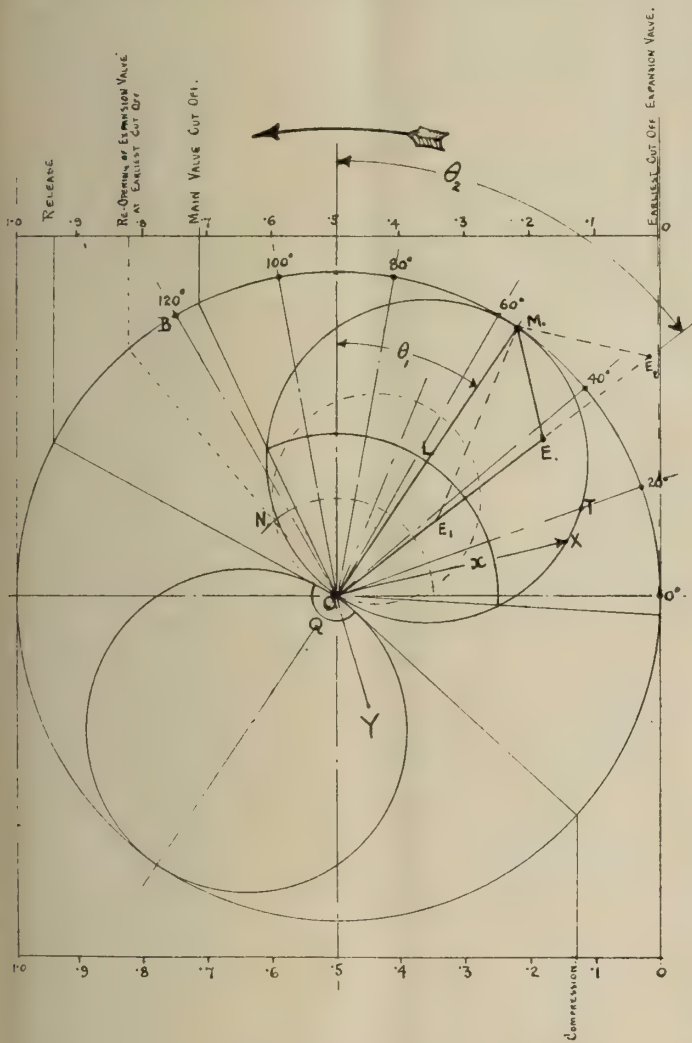
An arrangement has been entered into between Automatic and Electric Furnaces Ltd., of London, and August's Muffle Furnaces Ltd., of Halifax, whereby Messrs. August will supply coke, gas, and oil furnaces equipped with the Wild-Barfield (patent) Automatic Electric-Magnetic Detector winding of furnaces for correctly ascertaining the change point of carbon steel. August's Muffle Furnaces Ltd. will also advertise and sell the Wild-Barfield electric furnaces jointly with the Automatic and Electric Furnaces Ltd. The latter firm has obtained the sole rights for foreign countries for the sale of Messrs. August's coke, gas, and oil fuel furnaces, equipped with the Wild Barfield patents.

Messrs. Brown, Boveri and Co., London, have in hand at the present time an order for eight single-phase railway generators for the Norwegian and Swiss State Railways. Three of these are 11,500 k.v.a., 16,000 volt machines, with a frequency of 16⅔ cycles. Other large orders being executed by this firm include two 25-cycle, 10,000 k.w. turbo-generator sets, complete with condensing plants for the Anzan Steel Works, South Manchuria; four 12,000-kw. turbo-generators running at the exceptional speed (for the output) of 3,000 revolutions per minute for different users; and 22 single-phase locomotives, each of 2,000 H.P. continuous rating, for the Swiss Federal Railways. Several of these are in an advanced state of completion.

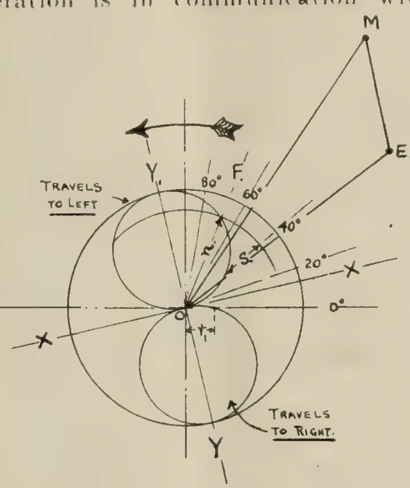
closed by the bar W were it not for the negative following lap p.

This partial closure will be more apparent at the later cut-offs. In this case we have the benefit of a full slot opening from the dead point to O X, after which the slot R gradually closes at exactly the same rate as the outer slot S. This is shown by the line R in Fig. 54, which is set off upwards from the base line. The vertical intercepts of the ordinates between the lines K and R may now be combined into one curve Q set off upwards from the lap line O L, then the shaded area shows the effective port opening through main and expansion valve into cylinder.

Throughout the above investigation we have only considered one-half of the expansion valve at a time. The reason for this is evident if we refer to Fig. 52. There it will be seen that the steam port in the cylinder at the opposite end to the one under consideration is in communication with the exhaust



Governors.—Fig. 50.



Governors.—Fig. 51.

opening, and will not be re-opened to steam by the main valve until the piston arrives at that end of the cylinder.

In this type of valve there is not much fear of the inner edge of the bar W overshooting the slot S in its travel to the left, and thus re-opening to steam before the main valve has cut off. But in order to assure oneself that this will not occur the bar V must be equal in length to M E.

Length of Radius Rod.	Diameter of Radius Rod.	Diameter of Suspension Link.	Diameter of Pin in Die.	Slot Link. Thickness of Metal in Link.	Die. See Fig. 48. G.	E.	F.	Governor Stand. See Fig. 48. A.	B.	C.	D.
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
28	$\frac{3}{4}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{11}{16}$	$\frac{7}{8}$	$1\frac{5}{8}$	$1\frac{3}{8}$	$4\frac{3}{4}$	$4\frac{7}{8}$	9	$6\frac{3}{8}$
28	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{11}{16}$	1	$1\frac{3}{4}$	$1\frac{1}{4}$	$4\frac{3}{4}$	$4\frac{7}{8}$	9	$6\frac{3}{8}$
34	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{3}{4}$	$1\frac{1}{8}$	$1\frac{3}{4}$	$1\frac{1}{2}$	6	$5\frac{7}{16}$	$9\frac{13}{16}$	$6\frac{9}{16}$
$35\frac{1}{2}$	1	$\frac{7}{8}$	1	$\frac{7}{8}$	$1\frac{1}{4}$	2	$1\frac{3}{4}$	6	$5\frac{5}{8}$	$11\frac{5}{16}$	$7\frac{1}{4}$
39	$1\frac{1}{4}$	1	$1\frac{1}{8}$	1	$1\frac{3}{8}$	$2\frac{1}{4}$	2	6	6	$11\frac{7}{8}$	8
$43\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{8}$	$1\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{4}$	6	$6\frac{1}{2}$	$13\frac{3}{16}$	$8\frac{3}{4}$

In fixing the drive for the Governor, a detail of which has already been given in Fig. 22, it should be noted that the driving pulley must not be less than $5\frac{3}{4}$ in. dia. by 2 in. wide, otherwise the belt will leave the pulley upon starting.

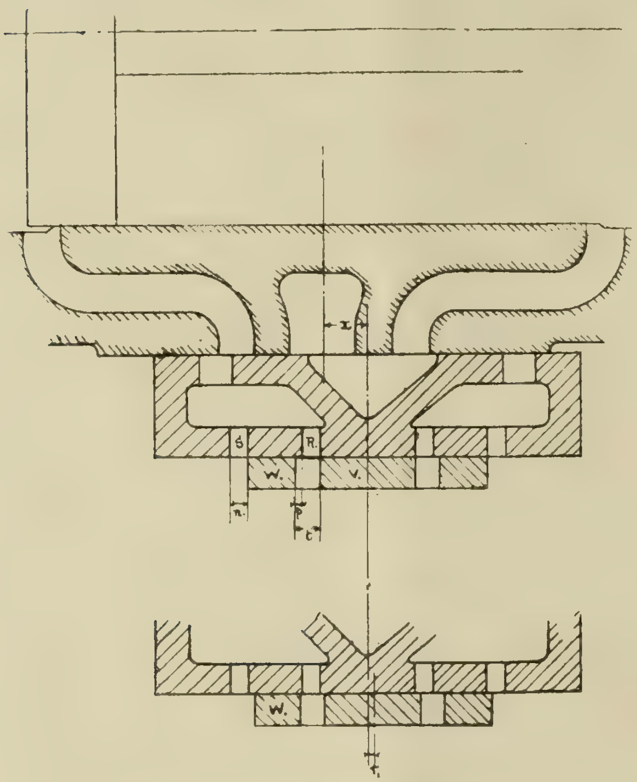
The least size of mitre wheels for driving the Governor Spindle may be $\frac{1}{2}$ in. pitch, 1 in. face, and each wheel should have at least 25 teeth, machine cut.

The proportions of the slot link and other details are as follow:—

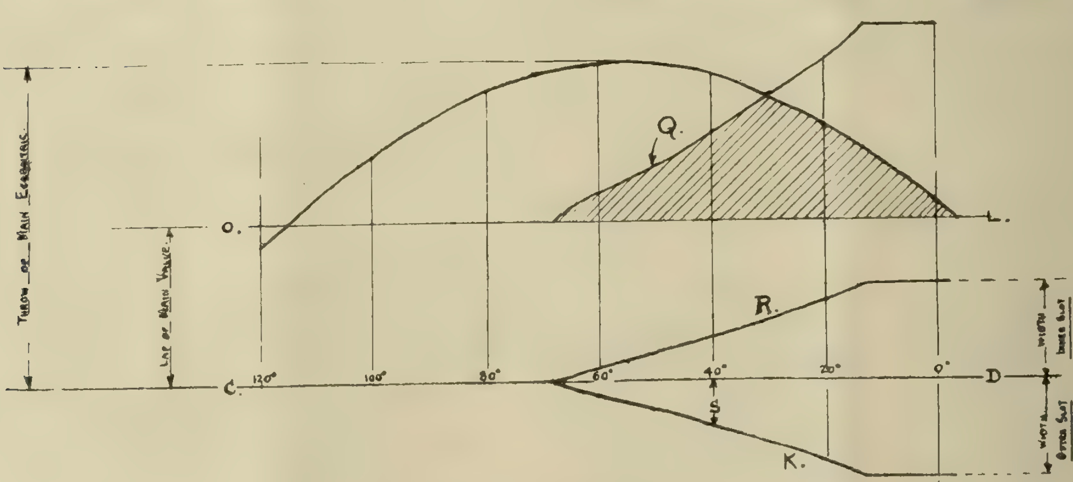
Lift of die in link = 3 times lift of governor.

Maximum lift of die = $2\frac{1}{2}$ times maximum travel of expansion valve.

Minimum centres of radius rod = $3\frac{1}{2}$ times lift of die.



Governors.—Figs. 52 and 53.



Governors.—Fig. 54.

The maximum inclination of the link should be such that the angle θ (Fig. 48) does not exceed $8\frac{1}{2}$ deg.

(To be continued.)

Messrs. Wellman, Seaver, and Head, the James Smith Hoisting Machinery Co., and the engineering department of Rosebery, Owen and Co. have amalgamated their businesses.

A NEW THEORY OF PLATE SPRINGS.

By David Landau and Percy H. Parr.

(Continued from page 244.)

Our next point is of still greater interest: it deals with the practical issue of the permissible loads which any spring may safely carry according to this new theory.

Since the short leaf of the two-leaf spring just considered is but one-half of the length of a single-leaf spring, the actual load W_1 which may be placed upon it is evidently equal to $2W_1$ (since for the same stress the load varies inversely as the length); hence, to produce double the pressure or reaction on the end of the short leaf we must place, on the end of the main leaf, 4/5 of the double, or 8/5 = 1.6 times the load that we can put on a single-leaf spring! Hence the conclusion, from the application of this new theory to a two-leaf spring, is that such a two-leaf spring having plates of the same cross-section, and equal steps, is only capable of carrying 1.6 times the load of a one-leaf spring. The old theory, then, which states that a two-leaf spring is double the strength of a single-leaf spring is therefore seen to be quite incorrect. Hence it follows, from what we have shown, we are correct in saying that a two-leaf spring has 1.6 times the strength of a single-leaf spring, and it is in this sense that we shall continue to use the word "strength" as applied to a spring: namely, the ratio of its supporting capacity (for a given maximum fibre stress in any one leaf) to that of a single leaf with the same maximum fibre stress.

A further application of our theory, quite similar to that just given, shows that a three-leaf spring has not a strength of 3, but only of 2.207; a four-leaf spring has a strength of 2.817, and a ten-leaf spring only 6.503. A twenty-leaf spring has a strength of but 12.689, instead of 20, as given by the old theory, the reduction of strength being therefore almost 40 per cent. These figures show very definitely the cause of failure from overloading springs designed on the assumption that the strength of such leaf springs varies in direct proportion with the number of leaves; it also shows why, when using the old

formulæ, it has been found necessary in practice to adopt a "coefficient" allowing for an abnormally low apparent stress as mentioned above; the fact being, of course, that the actual stress is very much higher—a condition our theory shows rationally.

In practice, it may be observed that for springs having a considerable number of plates there is, in addition to the master leaf, one or even several leaves having the same length as the master leaf; these leaves are called "full-length leaves." Our fundamental equation (7) deals readily with these cases, for any number of full-length leaves are exactly equivalent to a single leaf with a moment of inertia equal to the sum of the moments of such full-length leaves, and the fundamental equation allows for any relation between the moments of inertia of the various leaves.

To avoid tedious calculation of the reactions in each case, we have calculated the values of the reactions, as well as the strengths, for springs having up to as many as 20 leaves with one full-length leaf, and up to 25 leaves with six full-length leaves; these calculations are summarised in Tables I. and II. In both of these tables p is the number of full-length leaves in the spring, including the master leaf; k is the number of steps in the spring; and n is the total number of leaves, so that $n = k + p - 1$. Knowing the reactions, which are given in Table I., the strengths given by Table II. are easily determined.

Table I.

Reactions.

EQUAL SPACING.

K	$p=1$	$p=2$	$p=3$	$p=4$	$p=5$	$p=6$
1	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000
2	.8000	1.2000	1.6000	2.0000	2.4000	2.8000
3	.7357	1.0144	1.2931	1.5718	1.8505	2.1292
4	.7044	.9184	1.1324	1.3464	1.5604	1.7744
5	.6860	.8598	1.0336	1.2074	1.3812	1.5550
6	.6740	.8203	.9666	1.1129	1.2592	1.4055
7	.6655	.7918	.9181	1.0044	1.1707	1.2970
8	.6591	.7702	.8813	.9924	1.1035	1.2146
9	.6542	.7534	.8526	.9519	1.0511	1.1503
10	.6503	.7399	.8295	.9191	1.0087	1.0983
11	.6471	.7287	.8104	.8920	.9737	1.0553
12	.6445	.7195	.7945	.8695	.9445	1.0195
13	.6423	.7117	.7811	.8504	.9198	.9892
14	.6404	.7050	.7696	.8341	.8987	.9633
15	.6388	.6992	.7596	.8200	.8804	.9408
16	.6375	.6943	.7510	.8078	.8645	.9313
17	.6365	.6900	.7435	.7971	.8506	.9042
18	.6356	.6863	.7369	.7876	.8383	.8890
19	6350	.6831	.7312	.7793	.8274	.8756
20	.6344	.6802	.7260	.7718	.8176	.8634

Table II.

Strength of Springs.

EQUAL SPACING.

K	$p=1$	$p=2$	$p=3$	$p=4$	$p=5$	$p=6$
1	1.000	2.000	3.000	4.000	5.000	6.000
2	1.600	2.400	3.200	4.000	4.800	5.600
3	2.207	3.043	3.879	4.715	5.551	6.387
4	2.818	3.674	4.530	5.386	6.242	7.098
5	3.430	4.299	5.168	6.037	6.906	7.775
6	4.044	4.922	5.800	6.678	7.556	8.434
7	4.658	5.542	6.426	7.310	8.194	9.078
8	5.273	6.162	7.051	7.940	8.829	9.718
9	5.888	6.781	7.674	8.567	9.460	10.353
10	6.503	7.399	8.295	9.191	10.087	10.983
11	7.118	8.016	8.914	9.812	10.710	11.608
12	7.734	8.634	9.534	10.434	11.334	12.234
13	8.350	9.252	10.154	11.056	11.958	12.860
14	8.966	9.870	10.774	11.678	12.582	13.486
15	9.582	10.488	11.394	12.300	13.206	14.112
16	10.200	11.108	12.016	12.924	13.832	14.740
17	10.820	11.730	12.640	13.550	14.460	15.370
18	11.441	12.353	13.265	14.177	15.089	16.001
19	12.055	12.969	13.883	14.797	15.711	16.625
20	12.688	13.604	14.520	15.436	16.352	17.268

A study of Table II. of the relative strengths of leaf springs will reveal a very interesting point which is brought to light by the present theory; namely, that to carry too many full-length leaves in a spring is a decided disadvantage. Thus, a two-leaf spring is seen to have a strength of 1.6 and a three-leaf spring a strength of 2.207, while a three-leaf spring with $p = 2$ has a strength of 2.4, and with $p = 3$, or all the leaves full-length, a strength of 3, as might be expected *a priori*. A four-leaf spring with $p = 1$ has a strength of 2.818, and with $p = 2$ it has a strength of 3.043, which again agrees with expectation. But now observe that a four-leaf spring with $p = 4$ has a strength of 4, while a five-leaf spring with $p = 4$ is no stronger; this seems strange. Then notice that a five-leaf spring with $p = 5$ has a strength of 5, while a six-leaf spring with $p = 5$ has a strength of only 4.8; the addition of a short leaf has thus actually weakened the spring. Of course, such designs are outside of working experience, but the point is of considerable interest, as it shows that where there are several plates of the same length the addition of a shorter plate may actually weaken the spring. This is a condition which the old theory would never have suspected. We see, therefore, that there are limits to the corrected empiric equations of Henderson or Morrison which they did not announce; the absence of the *rationelle* of the correct theory of leaf springs naturally accounts for their not stating the limits in their expositions.

(*To be continued.*)

THE INSTALLATION AND OPERATION OF STATIC TRANSFORMERS.

By F. Ashton.

(*Continued from page 190.*)

Auto-Transformer Troubles.

For the class of work mentioned auto-transformers are very suitable, but careful consideration should be paid to the advisability of using auto-transformers on high-tension circuits in place of ordinary transformers with primary and secondary windings, for in some cases where this policy has been adopted, troubles have developed. An interesting case of trouble arising from the use of auto-transformers on high-tension circuits was reported some time back in one of the American technical journals. A certain electrical company arranged for the purchase of current from another company. The company selling the current had two sources of supply from which to provide this current—a 16,000-volt 60-cycle supply, and a 25-cycle, 2,300-volt supply. To couple these two supplies together, a frequency changer was installed, the machine being designed for 2,300 volts on the 60-cycle side. A transformer also had to be

used for raising the frequency changer's pressure from 2,300 volts to 16,000 volts, and then for raising the pressure of the total current (derived from both sources) to 22,000 volts. To meet these conditions a transformer was installed with the 2,300-volt windings mesh-connected, and these windings were connected up to the 2,300-volt frequency changer. The high-tension windings were star-connected, and were designed to give a pressure of 22,000 volts. In order to make these windings also deal with the 16,000-volt supply, however, each winding was provided with a tapping, so that the 16,000 to 22,000-volt transformation was carried out on the auto-transformer principle. In view of the fact that the 2,300-volt and 16,000-volt systems were isolated, the neutral of the auto-transformer was not earthed, because earthing would have involved changing all the two-pole relays on the automatic switches to three-pole relays, and this in turn would have involved the addition of another current transformer for each automatic switch. The transformer was rated at 3,600 k.v.a., and was made up of three single-phase units. When an attempt was made to supply current from the 16,000-volt system alone with the 2,300 delta-connection open, neighbouring telephone circuits were interfered with, but by connecting up the 2,300 delta-windings, this trouble disappeared. The next trouble occurred some time later, when one of the cables belonging to the company purchasing the power developed an earth, which raised the pressure of 16,000-volt system, and owing to the arcing at the point where the earth occurred a high-frequency surge was set up through the auto-transformer. This in turn caused arcing at the lightning arresters, which were completely destroyed. Since it was not permissible to earth the neutral point of the three-phase auto-transformer, owing to the expense of changing the relays on the automatic oil switches, the auto-transformer had to be replaced by a transformer with two secondary windings. As a matter of fact, if such a transformer had been used in the first instance, it would have only added slightly to the initial expense, and the troubles mentioned would have been eliminated. It certainly does not seem advisable to link large systems together with auto-transformers, even if they are earthed. More than one earth connection offers a path for harmonic currents which may interfere with telephones and load up the electrical apparatus to an undesirable extent. Moreover, current surges, such as that mentioned, have a free path from one part of the system to another, so that, altogether, transformers with primary and secondary windings are preferable because the electro-magnetic coupling allows more flexibility.

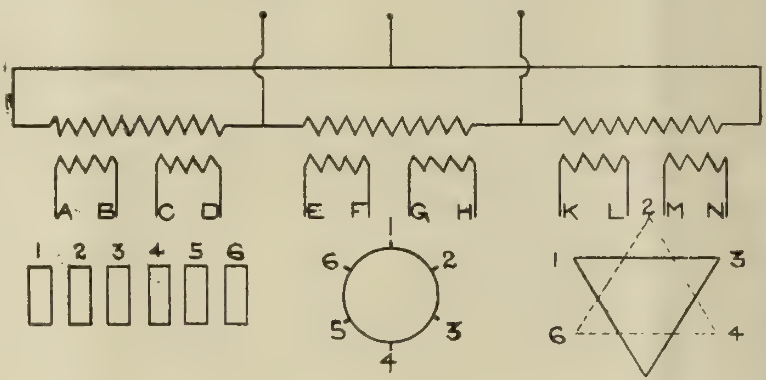


Fig. 24.—Diagram showing the method of making Double Delta Connections.

Six-Phase Connections.

In a previous article the double-delta connection for transformers feeding rotary converters was described, but the method of phasing out the various secondary windings has not yet been dealt with. In Fig. 24 the primary and secondary windings of three transformers, intended for feeding a six-phase rotary are illustrated, the primaries being connected in mesh in the usual manner. Each transformer has its secondary divided into two sections, as shown at AB, CD, EF, GH, KL, and MN. The slip rings of the rotary converter are represented by the six oblongs on the left, whilst the six points around the small circle in the centre of the drawing represent the positions of the armature tappings, which are connected to the slip rings. Should any difficulty be experienced in arriving at the order in which these tappings are connected to the rings, the machine may be run up to speed, and by taking voltage readings between the rings, which can then be numbered 1, 2, 3,, etc. One-half of the transformer secondaries must then be joined up to form one mesh connection, whilst the remaining secondary windings are joined up to form another mesh connection, each connection giving voltages displaced 180 degrees in phase, as represented by the full and dotted line triangles on the right of Fig. 24. To obtain this phase displacement, it is necessary to ascertain whether the pressure from A to B is in phase with that from C to D, and *vice versâ*. The same also applies to the windings FE, with respect to GH and KL with respect to MN. In other words, it is necessary to ascertain whether any of the secondary leads are reversed, and this may be done by connecting together the ends BC, DE, FG, HK, and L and M. With the primary windings energised a voltmeter connected between the ends A and N should give zero reading, whilst if connected between A and D, E and H, and K and N, the reading should be equivalent to twice the reading obtained between the ends as any one individual secondary section, such, for instance, as the ends A and B. Having obtained these conditions, one of the secondary mesh connections may be made as illustrated in Fig. 21 in *The Industrial Engineer* of December 21st; that is to say, A will be connected to L, B to E, and F to K. This gives the mesh connection 1, 3, 5, as shown by the full-line triangle. In order to make the voltage obtained from the second mesh connection differ by 180 degrees from that of the first connection, as shown by the dotted triangle 2, 4, 6, the secondary connections must be reversed. Lead C must be connected to lead H, lead D to lead M, and lead G to lead N. The complete connections then correspond with those shown in Fig. 21, where the con-

nections between the transformers and rotary converter slip rings are also indicated, and from which it will be seen that the first mesh connection is joined up to slip rings 1, 3, and 5, whilst the second mesh connection is made to the slip rings 2, 4, and 6, corresponding to armature tappings 2, 4, and 6, diametrically opposite the other set of tappings, to which the first set of secondary windings are connected. It is possible, however, that when the first set of mesh-connected secondaries were joined up to the slip rings they were connected in the wrong direction; that is to say, instead of the slip rings 1, 3, 5, representing tappings following round the armature in a clockwise direction, they represent tappings following in a counter-clockwise direction. If, on inspection, this is found to be the case, the transformer connections must be altered accordingly, but it must be remembered that the leads from the second set of mesh-connected windings must also be rearranged to bring lead 4 opposite 1, lead 6 opposite 3, and lead 2 opposite 5. In any case, it is extremely important to test the connections with the aid of lamps before making the permanent connections. All the six slip rings should first be connected to the transformers through lamps. With the primaries of the transformers energised, and the converter running, all the lamps should light up and go out together. It may be found that the lamps light up in pairs, and in this case the cables on which the lamps light up together should be noted, and the two remaining cables belonging to each mesh connection should be reversed. It may also happen that on one mesh connection all the three lamps light up together, with a single lamp on the other mesh connection, the remaining two lamps lighting up afterwards. In this case the leads connected to the last-mentioned lamps should be reversed. If the connections are incorrectly made other results may be obtained, such as the lamps belonging to one mesh connection attaining maximum brightness after the lamps belonging to the other mesh connection. This may be due to a double crossing in the connections, or the transformer sections may be connected so that the two meshes give voltages in phase with one another, instead of 180 degrees apart. What must be aimed at, and what must be attained before any attempt is made to parallel the converter with the transformers, is to get all the lamps to attain maximum brightness simultaneously.

(*To be continued*).

HYDRO-ELECTRIC POWER IN CANADA.

(*Continued from page 214.*)

Niagara Power Shortage.

In his second report the Consulting Engineer to the Commission of Conservation deals with the present power shortage in the portion of South-Western Ontario which is served from the Niagara Falls. The growth of the system directed by the Hydro-Electric Power Commission of Ontario is described. The yearly loads of the municipalities supplied have risen from 8,000 H.P. in 1910 to 250,000 H.P. (estimated) for 1918. The consulting Engineer proceeds :—

An Acute Shortage.

The present available supply of power for the 200 municipalities served by the Hydro-Electric Commission is exhausted. The shortage is acute. In October, 1917, the Secretary of the Commission sent an official notice to municipalities advising that, pending completion of the inquiry by Sir Henry Drayton respecting the power situation at Niagara Falls, as well as the inquiry held before the three judges appointed under the Water-powers Regulation Act, "no further contracts to be entered into for a supply of power nor for an increase in the load of the present power users."

The Toronto Commission is exerting every effort to compress its load, and to prevent even the natural increase in the requirements of its present customers. It can take on no new customers and has been issuing special appeals to present customers to use as little current as possible, particularly from 4-30 p.m. to 6 p.m. "on Mondays, Tuesdays, Wednesdays, Thursdays and Fridays, and so help to avoid a possible power shortage for munition plants and other essential industries. . . . Every economy, however small, will help to achieve the result aimed at. If each of the 50,000 Hydro customers in Toronto uses even one or two lights less during these hours, it will mean a greater reduction than if the whole of the street lights in Toronto were turned off."

Undoubtedly, much power and light are absolutely wasted. Not very long ago the vendors of electric energy were offering special inducements to encourage consumption, and customers were invited to use new electric devices as rapidly as such could be invented. The public has responded to these invitations and now, assuming that there is no set-back to industrial activity, Ontario is faced with a power shortage which, until relieved, must constitute a serious check to her industrial growth. The time is at hand when drastic action must be taken to curtail the use of electric energy now employed on luxuries, and thus make it available for necessary purposes.

Relief of Shortage.

The following are some of the means by which this shortage may be supplied :—

1. Increased utilisation of steam power. This, at the present time is out of the question as a means of dealing with the problem as a whole.
2. Supplying, temporarily, water from the unappropriated surplus, thus permitting the utilisation of the excess capacity of the plants at Niagara. It has been stated in the press that this has been provided for.
3. Curtailment of the power now used for street and other lighting, such, for example, as ornamental lighting; also for certain power purposes, in order to liberate more power for manufacture of munitions.
4. Utilising the water of existing plants under more efficient conditions, such as will exist in connection with the new Chippawa project, which will operate under a head of 300 to 305 feet. It will, however, be approximately three years before relief can be obtained by such means.

The Hydro-Electric Power Commission of Ontario is moving as rapidly as possible to have additional

equipment, including pipe-line, installed, so as to have available in about ten months an additional 50,000 H.P. from the plant of the Ontario Power Company.

5. Limitation of the quantity of power at present being exported from Canada to the United States. As manufacturers of war munitions in the United States also are short of power, such limitation will require very careful consideration in its international aspects, so that full justice will be done to interests on both sides of the boundary.

Chippawa Project.

The new Chippawa project which the Hydro-Electric Commission has started will, with the surplus water available, provide about 200,000 H.P., but, as stated above, cannot be available for approximately three years. The proposed size of the individual units, namely, 50,000 H.P., is larger than in any other hydraulic development in the world. Considerations of efficiency and desirable operating characteristics which it would be impossible to obtain with smaller units, have prompted the adoption of such large units. Power is to be produced at considerably lower cost than 9.00 dollars per horse power per year, which the Commission has been paying the Ontario Power Company for the 100,000 H.P. covered by the original contract.

As the Hydro-Electric Power Commission of Ontario now controls the Ontario Power Company, the unused water allotted to the Ontario Power Company will, it is stated, be diverted to augment the water supply available for the Chippawa project. If so, the capacity of the new Chippawa plant will be about 300,000 H.P. instead of the 200,000 H.P. above mentioned.

Preliminary work on this project, embracing surveys and other engineering activities, has been carried on during the last three years. Plant-equipment and tools for carrying out the work of construction were purchased some time ago, and much of this equipment is on the ground ready for operation.

Quantity of Power.

Details are given of the capacity of the large power plants in Canada at Niagara Falls, and it is shown that the shortage a year ago of power for present customers and firm contracts was 69,500 H.P. It is pointed out that the total power generated on the United States side of the Falls is 265,000 H.P. and on the Canadian side 388,500 H.P. Since Canada exports 125,000 H.P. to the United States, the power used by the two countries is: United States, 390,000 H.P., Canada 263,000 H.P. If the power were equally divided, Canada would have 63,250 H.P. more than she retains at present.

Electrical Heating.

In the course of a report on the heating of houses by coal and electricty, the Hydro-Electric Power Commission of Ontario point out that the climate of the greater part of the country is so severe in the winter that even the immense potentialities of its water power, if fully developed, would be altogether inadequate to cope with the demand for power for electric heating if this were fostered to any considerable extent. The difficulties in the way of utilising electric energy for the purpose are: (*a*) The enormous amount of energy that would be required and which could be more efficiently applied to other purposes. (*b*) The high cost of electric energy for heating as compared with other sources of heat energy.

Horse Power Required.

For example, says the report, there are about 80,000 homes in the City of Toronto; if each of these is to be heated and a demand of, say, only 12 H.P. per home must be met (probably a very conservative figure as an average for large and small homes) no less than 960,000 H.P. must be supplied for homes alone—no factories, no offices, no works, no street cars, no houses even, will get any lighting or power from this, it is all required on the coldest days for heating homes alone, and more will be needed in proportion, as the population increases. The great Chippawa scheme at Niagara Falls only contemplates developing 300,000 H.P. for the present and the entire maximum demand for all Toronto at present, including all power, lighting, and traction purposes is only in the neighbourhood of 125,000 H.P.

It may be added that the 6,000,000 H.P. which represents the estimated total possible development of Ontario water powers is not sufficient to supply merely the existing homes of Ontario with electric energy for heating alone, exclusive of all other domestic, commercial and industrial requirements.

A still further difficulty in supplying electric energy for heating on an extensive scale lies in the fact that all the heating is required in the winter only, and assuming that a maximum demand of 1,000,000 H.P. had to be met for supplying a city like Toronto, the load on the plant required for this purpose, throughout the summer months, would be practically nothing. In other words, for five months every year this enormous plant would be idle. Suggestions have been made that use might be made of it to supply certain industries which could be operated mainly during the summer months, but here there are two difficulties: (1) What are the industries on a large enough scale to be of any use? (2) How could such enormous undertakings afford to lie idle during the winter months when power is unavailable? The situation in this case would be just about as bad for the industries in the winter as for the electric stations, without the industries, in the summer.

(*To be continued.*)

DIESEL ENGINE USERS' ASSOCIATION.

The further list of additions to the membership of the Diesel Engine Users' Association announced at the meeting held this month is evidence of the increasing interest which is being taken in the general subject of oil as a fuel and in its use in engines of the Diesel and semi-Diesel type. The President, Mr. Napier Prentice, announced that at an early meeting a paper was to be read by Mr. Geoffrey Porter on the subject of engine wear, which, in view of the trying conditions under which Diesel and semi-Diesel engines had continued working for some years during the war, should be of particular interest at the present time, and the discussion of which, he thought, would prove to be very

useful and instructive. Mr. C. T. Bullough had proposed to give some particulars and to state his experience in connection with his system of electrically heating tar oil fuel, but his serious illness prevented him from attending, and it was proposed to circulate his notes on the subject among the members. An interesting announcement was the formation of a French Association of Manufacturers and Users of Internal-combustion Engines, and the suggestion that the two Associations should co-operate in promoting the interests of users and manufacturers of heavy oil engines was cordially supported. It was also stated that the subject of the allowance for depreciation in connection with income tax assessment purposes for Diesel and semi-Diesel engines was again receiving the attention of the Committee.

A discussion took place on the definitions of Diesel and semi-Diesel engines respectively. Draft definitions were submitted by Mr. Geoffrey Porter, with suggestions and proposed modifications by Messrs. James Richardson, A. Vincent Clarke, Napier Prentice, and others. There was some criticism of the use of the term "semi-Diesel" as applied to hot bulb or hot surface ignition oil engines, but the general opinion expressed was that although the expression "semi-Diesel" might not be in every way desirable, it was preferable to use a name which had now been somewhat generally accepted, and which was well understood and fairly simple, sooner than to use a more cumbersome nomenclature which might be more strictly correct. As a result of the discussion, the following definitions were approved, and it was decided to circulate them among the members and subscribers before final adoption:—

Definition of a Diesel Engine.—A Diesel engine is a prime mover actuated by the gases resulting from the combustion of a liquid or pulverised fuel injected in a fine state of sub-division into the engine cylinder at or about the conclusion of a compression stroke. The heat generated by the compression to a high temperature of air within the cylinder is the sole means of igniting the charge. The combustion of the charge proceeds at, or approximately at, constant pressure.

Definition of a Semi-Diesel Engine.—A semi-Diesel engine is a prime mover actuated by the gases resulting from the combustion of a hydrocarbon oil. A charge of oil is injected in the form of a spray into a combustion space open to the cylinder of the engine at or about the time of maximum compression in the cylinder. The heat derived from an uncooled portion of the combustion chamber, together with the heat generated by the compression of air to a moderate temperature, ignites the charge. The combustion of the charge takes place at, or approximately at, constant volume.

THE ELECTRIC SUPER-STATIONS: A FORECAST.

Speaking of the comparatively high though still actually very low thermal efficiency promised for the great central electricity generating stations recommended by the Coal Conservation Committee, Sir Dugald Clerk, K.B.E., D.Sc., F.R.S., in a paper read before the Royal Society of Arts on March 19th, pointed out that the average thermal efficiency of generation at the electricity generating stations of to-day is 8.5 per cent, so that the proposed efficiency of the great super-stations which is promised as 19.6, will be 2.3 times the present average. But great improvements are also taking place in the gas industry, he added, whereby the thermal efficiency of gas production, already far higher than that of the electric station, will be greatly increased and a larger proportion still of the heat value of the coal transferred to the gas holder. The gas industry in the near future looks for an efficiency of gas production of 75 per cent and an efficiency of gas distribution of 93 per cent, which will give a combined efficiency of slightly under 70 per cent. Comparing now the results aimed at in the future by the projected electricity super-stations and the perfected systems of coal gas generation, it appears that in the generation of heat gas will conserve for distribution 75 out of 100 heat units used in the works to produce the gas, while the great electricity station will distribute as electrical energy less than 20 of the heat units consumed. From the heat generating point of view, therefore, gas will be superior to electricity in the proportion of 3.8 to 1.

Further figures quoted by Sir Dugald showed that, as regards the production of power from electricity or gas after distribution, the thermal efficiency of electricity will be about 15.9 per cent as compared with 17.5 per cent in the case of gas; so that in the future the only field in which electricity shows any possible gain in respect of coal conservation is in lighting, for which the low pressure inverted incandescent burner will use at the gas works 30.3 B.Th.U. per candle hour while the 1-Watt electric lamp will use 23.5 B.Th.U. But even here the past records of gas invention show that great developments are still probable.

Publications.

Grits and Grinds for February the monthly publication of the Norton Co., Worcester, Mass., U.S.A.—contains interesting matter on "Polishing Cast-iron by Rumbling," "Arc of Contact," "Little-known Facts about Grinding and Grindery," and "Thread Chasers." This matter is practical in the extreme. We have two copies of this little journal, and the first two of our readers who apply can have a copy.

There can be no doubt that retarding factors are undoubtedly present which prevent reconstruction and development of our peace industries. These factors are outlined in a pamphlet published by **The British Engineers' Association,** the matter being prepared by Mr. D. A. Bremner, O.B.E., a Director of the Association. The retarding factors are set out, and range from labour unrest, through questions of finance, surplus stores still to be disposed of by the Government, to the "feeling of doubt and instability engendered by the rumours of the impending nationalisation of land, mines, railways, and certain other public services." The whole is dealt with shortly by Mr. Bremner.

Queries and Replies.

We shall at all times be pleased to help our readers out of their difficulties to the best of our power, and invite them to make use of this column for that purpose.

Steam Plant.—Do you know of a first-class, up-to-date work on the economical running and testing of steam plant?—Economy.

Trade Items, Notes, &c.

The Stoke-on-Trent Electricity Committee has placed an order for a 3,000-kw. steam turbine, three-phase generator, and condensing plant, with the British Westinghouse Co. Ltd.

Messrs. Hodgson and Sons Ltd., of Salford, have opened London offices at Cannon Street Buildings, 139, Cannon Street, E.C. 4. The firm have recently supplied a 100-ton railway weighbridge to the new steel works of Sir W. G. Armstrong, Whitworth and Co. Ltd., at Clayton, Manchester.

A new record was recently established when the circular shaft, Crown Mines, Transvaal, 20 ft. diameter, was sunk during December—31 working days—a distance of 279 ft., viz., from 655 ft. to 934 ft., showing an average of 9 ft. per 24 hours. This is the world's record, beating the last world's record of 252 ft. made in No. 14 shaft, Crown Mines. The drills used were Holman sinkers and Holman hand hammer drills.

The longevity of the steam engine built a generation ago is demonstrated by some figures given by Mr. F. Parr, the waterworks manager of Bridgewater. The pumping is done by two beam engines built by James Watt and Co., of Birmingham, in 1877, and working at a pressure of 10 lb. per square inch. The repairs bill in 1914 was only £4 12s. 8d., and in 1917 was just over £16 10s. The fuel consumption is not quite a ton a day, and the duty of the pumps 375,000 gallons per day.

According to figures issued by the Bureau of Navigation, Commerce Department, the sea-going American merchant ships of 1,000 gross tons or over on 1st January, 1919, comprised 1,663 vessels of 5,656,856 gross tons, of which 1,344 of 5,138,664 gross tons were steamers (including 60 vessels of 125,421 gross tons propelled by gas engines), and 319 of 518,192 gross tons were sailing vessels. In addition to these ships documented as merchant vessels, the War Department and Navy Department are operating as transports and for other war purposes former merchant ships, not at present documented as such, numbering 55 of 396,829 gross tons.

It is so obvious that ferro-concrete vessels are heavier than steel ones that there is no need to explain why. The important point is to make a comparison between vessels of the two classes, and of same deadweight carrying capacity. This information is derived from a paper read by Mr. T. J. Querette, of the North-East Coast Institution of Engineers, Newcastle on Tyne. The designs of vessels of 1,000 tons deadweight and upward prepared by the author's firm comprise one-deck, single-screw, cargo vessels of 1,000, 2,000, 4,000 and 6,000 tons weight, and the comparison is limited to those. The excess displacement of ferro concrete vessels over steel vessels of same deadweight carrying capacity is as follows: Deadweight all told, in tons, 1,000, excess 39 per cent; 2,000, 25.8 per cent; 4,000, 16.5 per cent; 6,000, 11.8 per cent.

At the seventh meeting of the Institution of Automobile Engineers, held on March 5th, Capt. G. W. A. Brown gave a most interesting paper in regard to the lubrication of the motor car. Capt. Brown's ideas on this subject are becoming well known to those who are studying the post-war car, and may be briefly summed up in the desire to eliminate grease cups, which the ordinary man never fills, or if he fills, never uses, and the substitution of complete lubrication for every part of the car. Manufacturers are recognising that the tendency will be, in these days of high wages, more and more for the owner to look after the car himself, and everything that will eliminate attention between runs will have to be adopted. The ballot for the election of new members of Council resulted in the election of the following members: Mr. A. E. Berriman, Sir Dugald Clerk, Messrs. C. Crompton, L. H. Hounsfield, Colonel J. S. Napier, Messrs. Henry Brearley, A. E. L. Charlton, J. H. Dickinson, L. A. Legros, Dr. W. R. Ormandy, Mr. S. Straker, Lieutenant-Colonel Brigg, Mr. L. Coatalen, Dr. Hele-Shaw, Messrs. T. Blackwood Murray and T. C. Pullinger. Before the war, the institution was in a position to place before parents who were anxious for their sons to enter the motor industry particulars of the facilities offered by the various firms throughout the country. The war has rendered most of these schemes obsolete, but the institution is about to recommend this important work, and is now obtaining information from the various firms, which will put it in a position to give absolutely up-to-date advice, which, it may be added, is given free of charge to parents.

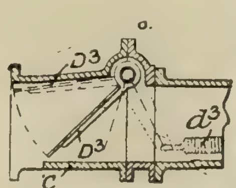
Patent Applications.

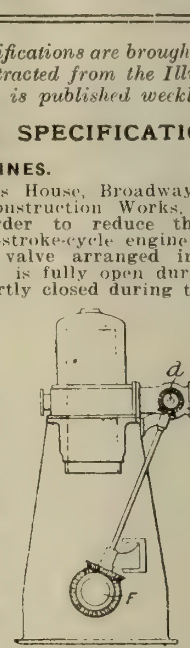
The following Abstracts of Specifications are brought up to the lates date possible, and are abstracted from the Illustrated Officia Journal of Patents, which is published weekly.

ABSTRACTS OF SPECIFICATIONS.

INTERNAL-COMBUSTION ENGINES.

119,275.—VICKERS LTD., Vickers House, Broadway, Westminster, and J. McKECHNIE, Naval Construction Works, Barrow-in-Furness.—Sept. 24th, 1917.—In order to reduce the quantity of scavenging air used in a two-stroke-cycle engine having piston-controlled exhaust ports, a valve arranged in the exhaust passage is so actuated that it is fully open during the earlier stages of the exhaust but is partly closed during the later stages.

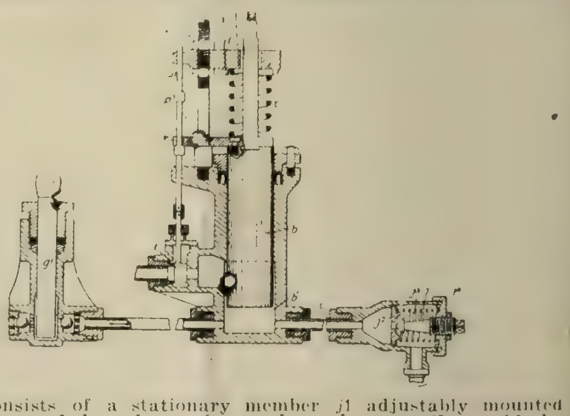




In the arrangement shown in Fig. 1, the spindle *d* of a rotary disc or cylindrical valve arranged in the exhaust pipe C is operated from the crank-shaft F by bevel gearing. The valve is so arranged that the exhaust passage is never quite closed. The rotary valve may be replaced by a cam-actuated mushroom valve. In another modification, a pivoted flap valve D3, Fig. 8, is arranged in the exhaust pipe C and is controlled by an adjustable spring *d3*, the position of the valve being determined by the pressure of the exhaust.

SPEED GOVERNORS.

119,286.—H. ELLIS, 28, Walter Street, Jarrow-on-Tyne.—Sept. 27th, 1917. A governor for a steam engine comprises a ram *b* adapted to be raised, when the engine races, by the delivery pressure of a pump *g1* driven by the engine. A spring *c* returns the ram and may be adjusted by nuts *d1*, *d2*. Th liquid escapes from the ram chamber *b1* by a pipe *i* and an adjustable valve *j1*, *j2*. The

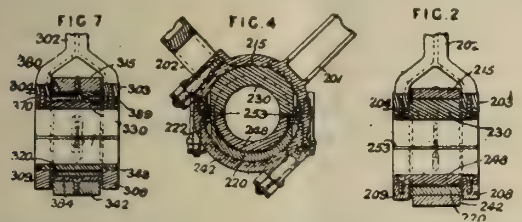


valve consists of a stationary member *j1* adjustably mounted in the cover of the valve casing, and a valve seat *j2* movable by the pressure liquid against the action of the spring *j3*. The spring may be adjusted by means of the screwed cover *j4*. Normally the valve is open, but when the engine races, the pressure liquid forces the seat *j2* against the valve *j1*. The ram at the top of its stroke opens an escape valve *l* by means of a tappet *r* and collar *p*.

BEARINGS.

119,332.—J. W. WATSON, Lancaster Avenue, Berwyn, Pennsylvania, U.S.A.—Nov. 14th, 1917.—Concentric bearings are so arranged that the inner brasses can be adjusted without disturbing the outer bearing surface. The invention is particularly applicable to radial-cylinder engines, *e.g.*, internal-combustion engines of the V-type. In the arrangement shown in Figs. 2 and 4, one connecting-rod 202 is forked and has semi-circular ends 203, 204 to which a brass 230 is secured, the lower brass 248 being secured to caps 208, 209 which are bolted to the ends 203, 204, liners 253 being inserted between the brasses in order to permit adjustment. The bearing-surface for the end 215 of the connecting-rod 201 and

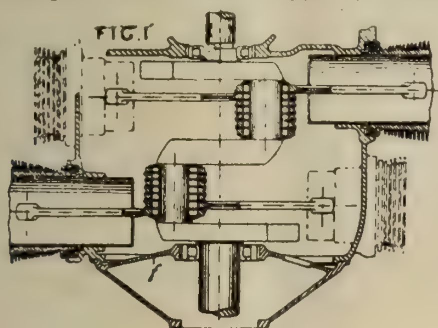
its cap 242 is formed by the outer surface of the brass 230 and a bronze or other half-ring 220 which is secured by screws 222 to the brass 230. In a modification, shown in Fig. 7, the bearing surface for the end 315 of the inner connecting-rod is formed by two steel half-rings 389, 320, the former of which is secured to the ends 303, 304 of the connecting-rod 302 by the studs 370 which secure



the brass 330, while the lower half-ring 320 is bolted to the upper half-ring 389. The lower brass 348 may be secured to the caps 308, 309 or may be loose, a clearance being left between this brass and the half-ring 320. Linings 380, 384 may be secured in the end 315 and in the cap 342.

INTERNAL-COMBUSTION ENGINES.

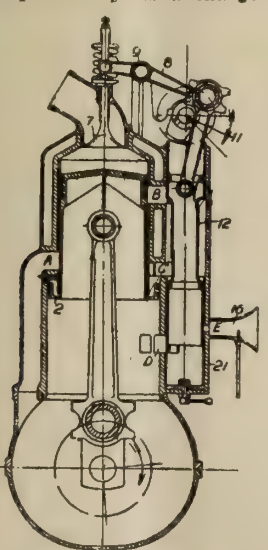
119,356.—A. H. R. FEDDEN, and BRAZIL, STRAKER AND CO., Motor Works, Fishponds, Bristol.—Dec. 19th, 1917.—In a radial-cylinder engine, the crank casing is cast in one piece and is provided with an orifice, closed by a cover-plate *f*, through which the connecting-rods, after being disconnected from the pistons, can be withdrawn



with the crank-shaft. An end bearing for the crank-shaft is provided in the cover-plate *f*. The crank-shaft may be a solid forging; and the cylinders may be disposed in one or more planes. The cylinder liners are secured by flanges and are removed prior to the withdrawal of the crank and the connecting-rods.

INTERNAL-COMBUSTION ENGINES.

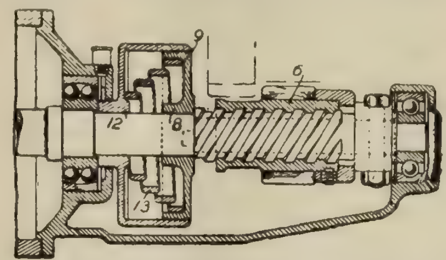
119,390.—W. ALEXANDER, 1, Broomhill Avenue, Whiteinch, Glasgow, and G. F. HALLIDAY, Howcans, Halifax.—Feb. 20th, 1918.—In a two-stroke-cycle engine having an enlarged portion 2 of the piston acting as a pump to compress a charge and transfer it



to the combustion chamber, and in which the crank chamber compresses air for scavenging and delivers it to the cylinder through a passage A, a hollow piston valve formed with a reduced neck 12 controls the inlet of the charge from the carburettor 16, the entrance of air to the crank chamber through the valve body and ports D, and the transference of the charge to the combustion chamber through ports B, C. The valve 12 is operated by a crank on a cam shaft 11 by which the exhaust valve 7 also is operated. So that the time of opening of the exhaust valve may be varied, the fulcrum 9 of the lever 8 consists of an adjustable eccentric. A sleeve 21 surrounding the lower end of the piston valve is adjusted to vary the admission of mixture at E and air at D.

ENGINE TURNING-GEAR.

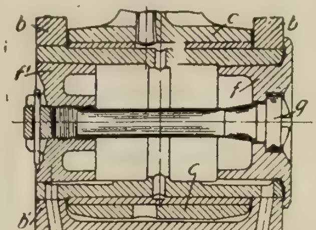
119,384.—ELECTRIC AND ORDNANCE ACCESSORIES CO. and F. WOOD, Ward End Works, Ward End, Birmingham.—Feb. 2nd, 1918.—In an engine starter comprising an internally-threaded pinion mounted on a motor-driven screw shaft, a buffer device cushions the movement of the pinion, and gives a solid drive when the pinion



meshes fully with the fly-wheel. The device comprises a sliding member 9 for engagement by the pinion 6, a fixed member 12 forming an abutment for the part 8 of the member 9, and an interposed spring 13. The members 9, 12 are preferably formed as a dash-pot piston and cylinder respectively, and the buffer spring 13 may be replaced by a light helical spring.

HINGED JOINTS.

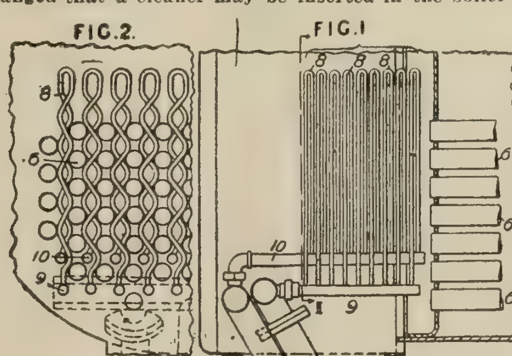
119,402.—F. H. ROYCE and ROLLS-ROYCE LTD., Nightingale Road, Osmaston Road, Derby.—March 20th, 1918.—Relates to joints, particularly articulated joints for the connecting-rods of internal-combustion engines, and has reference to the fixing of joint-pins by driving the tapered end-portions into tapered holes in the forked portion *b*, *b*1. To avoid permanent distortion, the ends



of the pin are expanded by tapering plugs *f*, *f*1 forced inwards by a bolt *g*, the amount of expansion approximately balancing the contraction due to driving in the pin. Metal liners filling the clearance space between the link *c* and jaw *b* may be used to prevent distortion of the jaws during the driving in of the pin. Or strips fitted between the jaws and shaped to clear the link *c* may be used for the same purpose.

STEAM-SUPERHEATERS.

119,506.—J. E. SLACK, 60, Queen Victoria Street, London.—Sept. 28th, 1917.—The tubes 8 of a superheater in a boiler smoke-box are connected to removable intermediate manifolds 9, 10 and are so arranged that a cleaner may be inserted in the boiler tubes 6

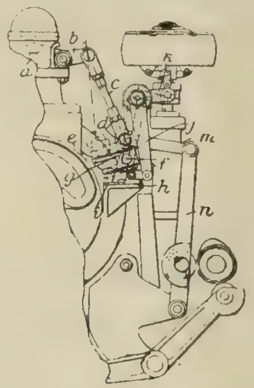


without disturbing the superheater. The superheating tubes may be formed with undulations and arranged opposite the spaces between vertical rows of boiler tubes, as shown. In a modification, the superheating tubes are connected to upper and lower manifolds and the bends of the undulations form passages opposite ends of the boiler tubes.

INTERNAL-COMBUSTION ENGINES.

119,422.—T. G. SMITH, Dudbridge Ironworks, Stroud, Gloucestershire.—May 21st, 1918.—The admission valve *a* is actuated by a

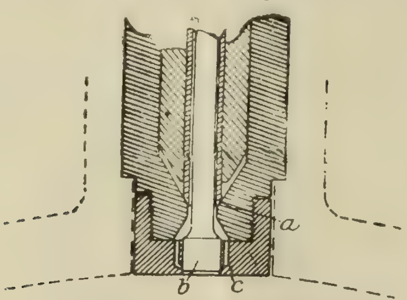
lever *b* connected by an adjustable rod *c* and link *m* to a cam-operated lever *n*, the opening of the valve being varied by a governor-controlled track *e* upon which bears a roller *d* secured to the rod *c*. To vary its inclination, the track is pivoted at *f*



and is engaged upon its underside by a block *i* connected by a link *j* to the lever *k* actuated by the governor. The track slides in guide-ways *g* and the block *i* moves along a bracket *h*. Two modified constructions are described in which the inclination of the distance-piece is effected by a screw actuated by the governor.

INTERNAL-COMBUSTION ENGINES.

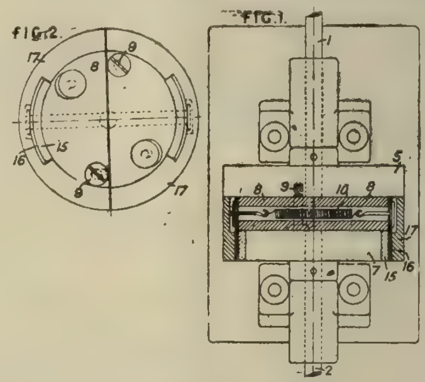
119,567.—A. R. McEWAN, 6, George Square, Greenock, Scotland.—Oct. 27th, 1917.—The fuel is controlled by two valves on the same



stem, a beat valve *a* and a cylindrical valve *b* which covers the outlet orifices *c* except during injection, and the issuing jets of fuel impinge upon each other; the orifices *c* are made in a separate flame plate.

CLUTCHES.

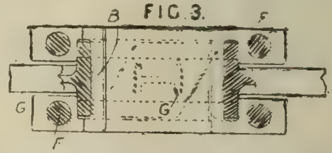
119,575.—W. CHADBURN, Dolcino, Ettrick Road, Branksome Park, Bournemouth, and W. R. CHADBURN, Weld Road, Birkdale, Southport, Lancashire.—Dec. 3rd., 1917.—In centrifugally-operated friction clutches, heavy blocks 8, turning on pivots 9 on the heavy plate 5 on the vertical driving-shaft 1, are connected by an



adustable spring 10, and carry ring-haive 17 in recesses in which are arranged plates 16 secured to the blocks 8 and provided with friction pads 15 normally pressed into engagement with a drum 7 on the driven shaft 2.

CONNECTING-RODS.

119,685.—H. R. RICARDO, 21, Suffolk Street, Pall Mall, London.—Oct. 6th, 1917.—In a radial-cylinder internal-combustion engine, the connecting-rods G are formed with curved shoes which engage



under inturned flanges on a bush B surrounding the crank-pin. The bush B is in two semi-cylindrical parts secured together by bolts F. A soft-metal lining may be interposed between the bush and the crank-pin.

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CONTENTS.

EDITORIAL.

MECHANICAL EVOLUTION.

IN literal deed and fact there is no finality to mechanical art; there exists no single process, system, or machine of which it can truthfully be said—this is the ultimate limit; progress cannot go further. Not that mere complexity represents finality, for simplification may be the next forward step. It is sometimes difficult to conceive in what direction evolution will next tend, but there is always assurance that the end is not in sight.

These facts lend an interest and enchantment to mechanical work denied in many other industries. Progress is extremely rapid, and ten years marks a metal-working epoch. When further improvement becomes difficult, or when process or machine seem perfected, when maximum complexity or simplification seems reached, some new alternative claiming special advantages in some direction or other is certain to arise. There are few things of which it can be said—this is the only way; usually there are many methods open, but only one immediate expedient. The exact prescription depends upon all the circumstances, since every means has limitations, which may be merits or drawbacks in the particular case.

To realise difficulty or disadvantage is the first step to its removal, and while the precise remedy finally adopted may be evolutionary, involving the passage of time and many steps, there is interest at every intervening stage. It takes many minds and much patient disentanglement to solve even simple matters in the best possible way.

Looking backward from the finish, or viewing the completed job, whether machine, structure, plant, or device, the result seems obvious. It takes a specially acute mind to realise the numerous problems which in sequence had to be solved before completion. The alternatives are usually numerous, selection of the precise solution chosen was difficult, sometimes a deadlock requiring much original thought and study led to an inversion of standard practice. In any event, a design which is not the sincerest form of flattery represents an expenditure of thought and origination of idea, added to a visualisation of need, besides the material, which stands as the permanent expression of all these intangible factors.

The realisation of individual want is by no means an indication of universal need. Between the solution of an individual problem and the provision of a marketable commodity there is a great gulf; it is the province of manufacture to bridge this gap; done successfully, this is business achievement. Having accomplished this much, it is insufficient to rest satisfied; improvement is in the nature of mechanical art, and has to be continuous. The novel of to-day is the usual of to-morrow; it is essential to maintain progress if reputation is to survive.

Life itself may be a period of probation; certainly we are all pupils in its school from first to last; capacity for the absorption of new ideas is by no means inversely proportional to age. In a progressive and established business there is usually a balance between past practice and new idea. This balance serves to make certain of proven merit and real utility before the new is released for sale; the novelty must prove itself before it is entrusted with the reputation of its maker. Every concern established in public confidence jealously guards their reputation; as a consequence, the reliance placed in

products of a well-known source is justified. The trouble begins, and the descent is commenced, when reputation is used to foist inferior or undependable products under cover of a well-known name.

Reliability is cardinal to engineering production, and the re-establishment of shattered confidence is the hardest task it is possible to undertake.

THE INDUSTRIAL SITUATION.

From an Employee's Standpoint.

[The following article has been forwarded to us for insertion, and we have pleasure in publishing it, although we do not wholly agree with all the arguments. Still, our policy is to consider all sides of industrial life, and we shall welcome correspondence on this grave and acute question.—Editors, *I.E.*]

The industrial situation of to-day is one fraught with imminent danger to society. In spite of hopes that the position in the labour world would improve, the probabilities of a general upheaval are now more in evidence than at any time since the declaration of an armistice.

Unemployment, largely due to the difficulty experienced in obtaining raw materials, is ever on the increase, and with the rapid demobilisation of our armed forces, is likely to reach dimensions sufficient in themselves to cause great anxiety.

In every phase of industrial life the outlook is most ominous, and in no direction is the position more grave than it is where our principal staple industries are concerned.

Coal, cotton, transport, engineering, and shipping are the industries where the spirit of unrest is most marked, and where the general dissatisfaction is most manifest.

During the war period the workers have been toiling under abnormal conditions, both with regard to the duration of working hours, scarcity of wholesome food, scantiness of means of recreation, and in many cases sorrow for the deaths and anxiety for the lives of those dear to them.

As a result, they have developed an irritability and jumpiness totally foreign to their usual demeanour. Further, they are labouring under a pretty well-defined sense of injustice, and feel themselves aggrieved by the failure of those in authority to redeem the specious promises made to them during the war period. They have been maligned and misrepresented by a large section of the press; they have been, along with the other sections of society, fair game for a relentless and grasping gang of profiteers; and, though they have had their wages increased, they find that economically they are worse off than they were in pre-war times.

Very little credit has been given to the workers for the spendid sacrifices they made in the interests of the commonwealth. They agreed to the abrogation of trade union conditions, to the dilution of labour, and to the working of systematic and excessive overtime.

Whilst wages had been increased, so also had the price of commodities, but the latter in a far greater ratio than the former. In addition to this, they had been called upon to pay direct taxation in the form of income-tax, as well as indirect taxation on foodstuffs, amusements, and in various other ways.

The provisions of the Defence of the Realm Act prevented them for a considerable period from changing their venue of employment, except they were prepared to suffer certain penalties, and as a consequence they began to feel that their personal liberty was being unduly interfered with, and to put a final touch to the whole business, they were promised at the end of the war the immediate creation of a new heaven and a new earth for them. Society was to be altogether reconstructed, work was to be plentiful, wages were to be high, housing was to be improved, and all was to go as merry as a marriage-bell.

The failure of our great politicians to carry out their promises, or even to indicate some tangible method of securing these much-to-be-desired conditions, has filled even the steadiest-going workers with the feeling that they have been betrayed, and, as a consequence, they, the workers, are rapidly coming to the conclusion that, if better conditions of life and labour are to prevail, they themselves will have to make them.

All the shrieking of the gutter press about Bolshevism, German money, and other equally-idiotic and absurd catch-words, will not affect the position one iota. Organised labour is out for better conditions of life, and means to have them.

The question of the hour is: "How are these better conditions to be brought about?" The answer undoubtedly is, by the exercise of mutual goodwill and common sense by the representatives of both the employing and employed classes; not by the frothy speeches of political charlatans of any hue, but by real, live representatives of both the interests concerned.

There are many men among the employers who have the goodwill and esteem of the workers, and such would be welcomed at any conference having for its object a definite settlement of the claims of both sides. In the ranks of the employed there are scores of broad-minded, honest, and efficient men, who are prepared to discuss and solve the problem of industrial unrest and the creation of a better understanding for the future, having due regard to the real interests of the community.

From such elements a grand national conference might be called, at which the whole situation could be discussed, definite proposals put forward, and an engagement given, mutually, to use every endeavour to have those proposals carried into effect.

Such a conference ought not to be composed entirely of the official elements of either side. Employers, other than Federation representatives, might be included on the one side, and workers direct from the shop or factory on the other. From such, first-hand knowledge of the various grievances would be available, and both sides would be in closest contact with those they represented. A conference in which labour is only represented officially by trade union leaders will not be satisfactory, as many of these are altogether out of touch with those they profess to represent.

Concerted action by the workers is threatened in the triple alliance of coal, dock, and transport workers.

If such action be taken, the whole of society will suffer. Let reason and common sense prevail. Let the parties concerned tackle the whole problem in a fair, honest, and broad-minded way, and a solution will be found, and Bolshevism, so far as these islands are concerned, will become as dead as the dodo.

There are legitimate grievances on both sides, wrongs to be rectified, and misapprehensions to be dispelled; but an honest and sincere endeavour by both sides will bring about general industrial peace, assuring to us as a community continued progress on the lines of genuine mental, moral, and physical development.

METALLIC PACKING.

A MICROSCOPICAL INVESTIGATION.

By James Scott.

The idea, still widely prevalent, that metallic packings are quite a modern invention is mistaken, because in the year 1797 Edward Cartwright patented a contrivance of this character. But it must be admitted that only within recent times, comparatively speaking, have these valuable adjuncts obtained supremacy for their particular purpose. Even now, however, there is plenty of need for enlightenment into the details of the attributes to be looked for on their behalf, and the reasons why some classes are better than others, and a few may fail altogether in properly fulfilling their important functions.

Packings may be divided roughly into three main types, namely, fibrous, metallic, and fibro-metallic, the names of which sufficiently denote their composition. Those of the first kind still claim many

Fig 1.—One twenty-fourth inch of the working surface of a metallic packing, white metal, half-ring, in its fresh state, showing the individual granules, each of which is composed of masses of particles; highly magnified.

adherents; but it appears to me, independent as an investigator into these subjects, that the true metallic packing is fast superseding all other forms.

The main desirable qualities sought in a packing are: that it shall not scratch the rods; shall reduce or nullify friction; shall serve as an efficient bearing for the rods; must not be liable to disorder, nor require continual readjustment; must be durable and inexpensive; besides being gas and vapour-tight.

When these points are assured it may be expected that the efficiency and strength of the cylinder will

Fig. 2.—One twenty-fourth inch of the working surface of a metallic packing, white metal, half-ring, after slight wear, showing slender parallel grooves, and lubricating flakes of dislodged metal; resistance grains, etc.; highly magnified.

be thoroughly maintained, since it will only be submitted to legitimate, and not unfair, wear.

The majority of metallic packings consist essentially of white metal, concerning which so much irresponsible matter has been written that a few words on this matter may be admissible. The original Babbitt metal was composed of about 7.4 per cent antimony, 3.7 per cent copper, and 88.9 per cent tin; but the present brands generally range from antimony 5 to 15 per cent, copper 3 to 10 per cent, and tin 80 to 90 per cent. When the price of tin advances to much extent it is customary to reduce its proportions, and replace it by copper. In many cases, lead 5 to 6 per cent, is added to the other ingredients.

Several firms have made variations on their own account, and defined them by improvised terms; but most of those used for metallic packing contain antimony, copper, lead, and tin, with which zinc is occasionally incorporated. Besides these substances, small quantities of other metals may be provided. Good commercial packings have been proved to contain: (1) 3.51 per cent antimony, 7.78 per cent copper, 0.25 per cent lead, and 88.1 per cent tin; and (2) 0.5 per cent antimony, 0.02 per cent aluminium, 64.3 per cent lead, 0.01 per cent manganese, and 33.3 per cent tin. Traces of other metals are also present.

It is not implied that these recipes cover the constitution of the packing illustrated, with the representative mechanical behaviour of which I am most concerned. The special kind of packing that I have at present in view is the ringed one, in which semi-

circular sections of white metal are placed round piston rods of ¼ in. diameter upwards, to form sets of superimposed collars or hoops. I have selected it for treatment because of its high degree of merit in so many directions, and not to infer that other makes are inferior in their own respective departments. This packing can be used equally well in connection with machines engaged upon the manipulation of air, ammonia, brine, carbon-dioxide, gases, oils, spirits, tar, varnish, water, etc., besides Diesel and other internal-combustion engines, rotary pumps, and so forth. It is the very well-known Snowdon's metallic packing. This excellent commodity consists of half-rings, square in cross-section. Each half-ring is hollow, sufficiently thick, and is compactly filled with oiled graphite of the most unctuous kind, the ends of the contrivance being sealed with metal. A small number of pores or openings, visible to the naked eye, have been drilled on the inner or working curve of each half-ring, giving freedom to the contents when wanted.

During use, the heat developed by friction softens

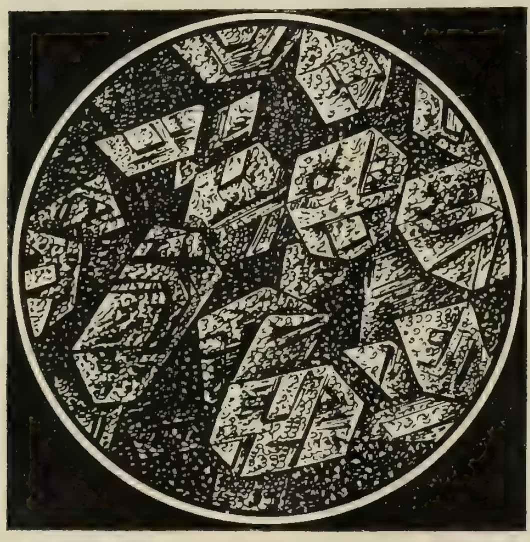


Fig. 3.—One twenty-fourth inch of a layer of oiled graphite which oozes from pores in the working surface of a metallic packing, white metal, half-ring, and adds to the lubrication, owing to the ease with which it crumbles; highly magnified.

the more amenable ingredients of the metal, which, by becoming plastic, are pushed to and fro between and around the denser grains, the latter serving meantime as a support for the whole structure. Pressure, suction, and increasing temperature forces out a trifle of the oiled graphite, and this confers its beneficial lubricating properties on the outside of the metal. The microscopic particles of metal, instead of wearing off to a noticeable extent, are simply shifted into different positions in the same mass, remaining throughout in almost identical relationships with each other, and allowing the piston-rod to slide or glide undisturbed.

Metallographers etch alloys with various chemicals to elucidate their true structure. Dilute nitric acid, for instance, dissolves some of the different components, and leaves the remainder standing out in their real formation. It is possible, when advisable, to separate, identify, and calculate the respective percentages of all the metals used in any composition. As an instance affording an insight into the chemical side of the matter, file off a little of the white metal of the packing on to a glass slide, and add a drop of dilute nitric acid to the dust thus obtained. Within a few hours it will be dissolved by the acid, and converted into salts modified into beautiful sparkling crystals and dull powders of many tints. Uncombined metals would yield yellowish antimony pentoxide, blue copper nitrate, white lead nitrate, and white tin nitrate, which rapidly decomposes into stannic acid, and so on; but the packing now described gave greenish-yellow, yellowish, greyish, and white crystals and deposit, after the solution had evaporated, thus indicating that the individual metals had been well compounded in the alloy. In chemical analysis many intricate reactions have to be taken into consideration.

In Fig. 1 is shown a surface view of the chosen metallic packing half-ring in its fresh state, as it is left after cooling in the mould. The granules are apparently irregular, with interstices between them occupied by other grades of mixture, but they are really crystalline and symmetrical, embedded in a matrix which has flowed over and around them, with intervening gaps containing the final settlement. There is a great deal of variation in the softness and hardness of the respective particles, and upon this fact depends the value of an alloy of this series.

In Fig. 2 is shown the working surface after slight wear. The steady friction has rolled the microscopic external particles together in parallel rows, pressure causing furrows and ridges which are responsible for the polish visible to the naked eye. Very minute scraps of dislodged, but still adherent, metal and graphite (this is white and shining when rubbed) can be seen, and have served as a lubricant to resist actual removal of too much metal. Fine, irregular, dark lines indicate the interstices between the denser, supporting granules. Durability is ensured by the constant change of position of the lubricating flakes and the meagre depth to which penetration of the metal occurs.

A file-cut, when magnified, reveals brassy and rainbow colours, due to the presence of copper and refraction of the light from the multitude of slender ridges and grooves due to the process. So delicate is the texture of this metal that a mere few rubs with a piece of paper will alter its surface, converting the granular surface into slender furrows. It is this easy responsiveness which is so effective in resisting wear. It should be borne in mind that only the thinnest of layers is actually affected, and that even when fair wear removes a film, the remainder of the metal thickness represents thousands of similar ones.

In Fig. 3 is shown some of the graphite concerned in the operations. This is crystalline, and, therefore, preferable to the oft-times gritty, amorphous kind. Each tiny scrap is an angular flake made up of a combination of still smaller ones, and these in turn are composed of united "atoms." The slightest touch suffices to separate these particles, which appear to me to actually diffuse through the entire metal, assisted by the accompanying oil.

The oil can be extracted in faint globules by stir-

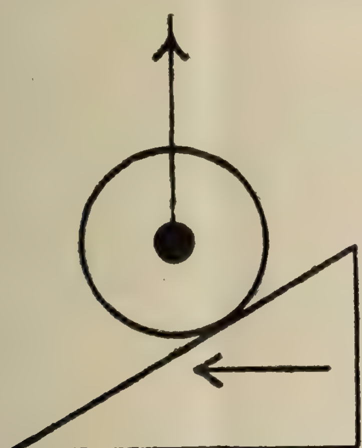
ring the graphite in hot water. If some of the graphite is placed on a glass slide and heated, there will emerge a vapour which can be condensed on to a piece of glass held close above it, thus proving that owing to its limpidity heat induced by friction tends to drive it out from the ring pores in a satisfactory manner.

White metals are practically self-lubricating; but when they are systematically supplied, automatically with a high-grade, doubly useful addition, such as oiled graphite, the combination of merits would be difficult to surpass.

CAMS.

By W. E. Bennison, A.M.I.M.E.

The cam is a simple piece of mechanism. Possibly it is because of its simplicity that many busy engineers neglect to study it, or that most writers of mechanical text-books make but scant mention of it. Yet ignorance of cam action may lead the engineer very far astray. Lack of knowledge is often met with on the part of first-class men concerning the principles governing this mechanism. Cams are



Cams.—Fig. 1.

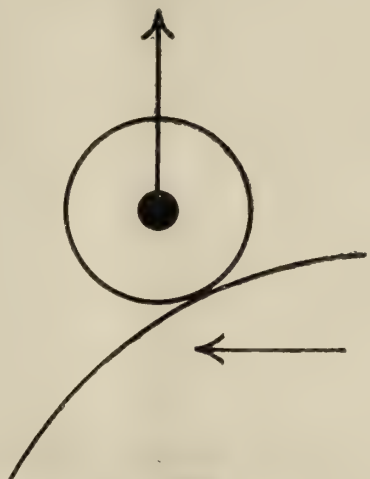
frequently seen performing their functions badly, having apparently been designed by haphazard methods. On the other hand, acquaintance with the principles will usually enable the designer to attain his ends surely and quickly.

Definition.

When the question is asked, What is a cam? a somewhat chaotic state of ideas is at once revealed, and it is found that many engineers have but a hazy conception as to what constitutes a cam. All manner of curved or inclined pieces, slotted bars, and even fixed projections, are called cams by one or another. An approach to the text-books does not help very much, for if the majority of writers have left the subject alone, those who have tackled it do not seem to be altogether happy in their definitions. It would appear as though any curved or inclined piece may be called a cam, no matter what shape it may be, no matter what form of motion it possesses. Rankine, however, does distinguish between a cam—a piece having angular motion, and a camplate—a piece having rectilinear motion.

The writer proposes the following definition, and will keep to it for the purposes of these articles:—

"A cam is a member with an inclined surface having angular movement abouts its axis: this inclined surface acting upon a second member, whose movement is controlled in a definite manner, causes motion in the latter. The contact



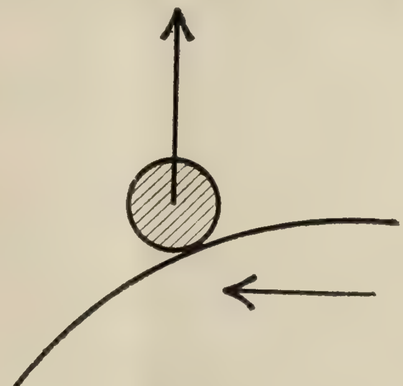
Cams.—Fig. 2.

between the two members is either line or point contact, or approximations thereto."

This definition is also intended to cover the exact converse in which the second member has angular movement around the axis of the first member, which is fixed in space. The portion of the actuated member which is in immediate contact with the cam surface, will be called the "follower."

Uses of the Cam.

The author is unacquainted with the history of the cam, nor does it seem profitable, in a practical treatment of the subject, to inquire into its history. It is an old piece of mechanism, and was possibly used first on some of the earlier printing machines.



Cams.—Fig. 3.

Nowadays the cam is one of the most useful pieces of machinery in use, and it is only by its adoption that many modern machines are possible.

The following are a few of the machines in which cams are used: Sewing machines, slotting machines, gas engines, petrol engines, Diesel and heavy oil engines, automatic turning and screwing

machines, printing machines, stereotyping machines, typecasting and setting machines, cotton machinery, bleaching and finishing machines, punching machines, and almost any automatic machine.

It is when time is the important factor that use is made of the cam. Most mechanical movements can be obtained by means of cranks, eccentrics, linkages, etc.; but when several operations have to be performed each having a definite relation to the others in the matter of time, the designer usually falls back upon the cam. The cam provides a comparatively cheap and simple means of obtaining many complicated timing movements, which would otherwise require very complex mechanism. Anyone doubting the accuracy of this statement is asked to evolve a mechanism to operate, say, the valves of a petrol engine without using cams.

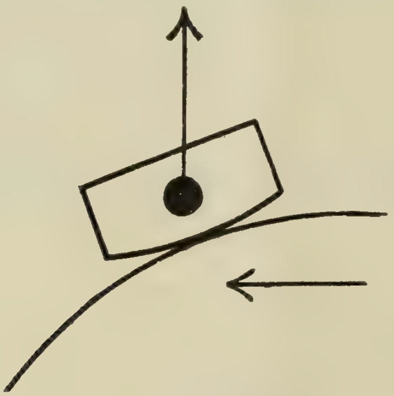
To generalise, it may be said that cam motion is the conversion of angular motion into one of the following:—

(*a*) Rectilinear motion.
(*b*) Angular motion in another direction.
(*c*) Motion along any curved path.

The motion given by the cam may be reciprocating or in one direction only. In the latter case the actuated member must be returned to its original position by some other means, such as a weight or spring, or other mechanism.

Mechanics of the Cam.

Mechanical Principle.—The mechanical principle involved in the cam is that of the inverted inclined plane or wedge. The inclined surface of the cam presses against the follower with a wedge action and forces it to move. The movement of the follower is usually constrained to be in a definite direction, either by



Cams.—Fig. 4.

means of guides or by the position and fixing of the piece carrying the follower.

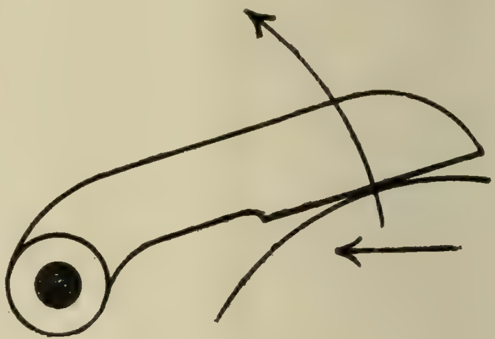
The inclined surface of the cam need not necessarily be a flat one. It may be an inclined plane whose slope is constantly changing; in other words, a curve. The tangent to the curve at any point gives the slope of the equivalent incline at that point.

Various Forms of Contact.—The contact between the cam surface and the actuated member is usually made by means of a roller, a circular peg, a rounded block, or a flat surface.

Fig. 1 shows a wedge acting upon a roller, and Fig. 2 shows a cam curve in contact with a roller. In dealing with the kinematics of the cam it is always the centre of the roller whose motion is investigated. Fig. 3 shows a cam curve in contact with a circular peg. The only difference between this example and Fig. 2 is that the peg is rigidly fixed to the actuated member, and the roller revolves about its axis. The centre of the peg corresponds to the centre of the roller.

Fig. 4 shows a rounded block in contact with a cam curve. The block may be either fixed or pivoted. If pivoted, the centre of oscillation corresponds to the centre of the roller or peg. Fig. 5 shows a cam curve in contact with a flat surface.

Every one of these forms, except the roller, gives sliding contact. The roller gives rolling contact,



Cams.—Fig. 5.

and therefore, on account of the lesser friction, is much more largely used than any other form. It is owing to the great use of the roller in actual practice that it has been thought advisable, in the majority of examples to follow in these articles, to show roller contact.

Cam Curves.—The curvature of cam surfaces falls under three general classes, viz.:—

(*a*) Spiral curves.
(*b*) Helical curves.
(*c*) Curves which are a combination of (*a*) and (*b*).

Spiral Cam.—(*a*) The spiral cam is usually a plate or disc revolving or oscillating about its axis, and it is the edge of the disc which acts upon the follower. The spiral curve tends to force the follower to move in a plane perpendicular to the axis. Usually the direction of motion is roughly towards or away from the centre, though the line of motion does not necessarily pass through the centre.

Helical Cam.—(*b*) The helical cam is usually a cylinder revolving or oscillating about its axis, and the helix is cut or fixed on to the periphery of the cylinder. The helical curve tends to force the follower to move in a plane parallel to the axis. The direction of motion is usually roughly in an axial direction, though not necessarily parallel to the axis.

Combination Curves.—(*c*) This class is not common. The cam forms a sort of conical surface which partakes of the elements of both the other classes. The movement is not confined to one plane, but will be a compound one, being the resultant of two motions, one at right-angles to, and the other parallel to the axis. To trace the motion usually involves a very complicated geometrical construction.

The curves of cams may be regular curves, such as the Archimedian spiral or regular helix. On the other hand, the curvature of the spiral or the pitch

of the helix may be constantly changing, and the rate of change may be irregular.

The methods of setting out various cam curves will be dealt with later.

(To be continued.)

SOME INTERESTING POINTS IN RELATION TO OIL PROSPECTING.

We have received a copy of a most interesting letter written by Mr. Maybury of California, U.S.A., to his brother Mr. J. D. Maybury, of Church, Lancs. The letter is so interesting and full of material that we have no hesitation in publishing it.

Oil in Derbyshire.

"I felt very interested about what you said in regard to England being in search of oil for her shipping, and what that old pioneer in oil, Lord Cowdray, and some others, say, and in particular in the newspaper clipping you sent me of the progress you have made and are making up to date in the search for oil in Derbyshire. Now, I don't claim to be infallible in locating oil or water, but I do know what I have done up to the present time, after 31 years' practical investigation in both the locating of oil and water and refining the same. Now, I would say from what I can gather from paper cuttings: the Report says in one that they are down 1,000 feet into the coal bed and are making from 40 to 70 feet a day, and expect to strike oil in about 1,000 feet more, or when they get through the coal. To this I would say: they will never strike any oil in a coal-bearing formation, if they bore or drill through to China or Hades; from the fact that coal contains no petroleum oil. We can take the lignites, the bituminous, cannel, down to the anthracite coal, which contains some 96 per cent carbon. We can pulverise any and all of them and press them with all the pressure we can command, but we cannot get one drop of oil from any of them. But if we put the coal through the process of destructive distillation we certainly will get an oil from it, but it is found that the oils wet get all contain carbon, hydrogen, nitrogen and oxygen all chemically combined, and are not petroleum oil. We can fractionate the oil thus obtained from coal, as often as we will, but each fraction will still contain the same elements more or less.

"Vegetable matter, when put through the destructive distillation, gives similar oils containing the very same elements, but in varying proportion.

"The same can be said of animal matter; thus, we call them organic oils, from the fact they are produced from organic substances.

Prospecting Difficulties.

"Prospecting for petroleum oil in your country is more difficult and expensive than in newer settled countries, from the fact all topographical indications are long ago destroyed and obliterated, from the fact of it having been under cultivation so long; the advice of the present-day geologist is nil in such matters as the locating of either oil or water-bearing lands. At their best in this and other countries, I find all they can do is to suppose, which is very costly to those who are 'wild-catting' in any country where there are no surface indications. No one knows this better than those who furnish the money for 'wild-catting' for either oil or water.

Fake Oil Locators.

"Now the oil boom has struck your country you are very liable to have a large surplus of fake oil locators, as you have in the past fake water witchers, or dowsers as you call them; not but that the fork stick or divining-rod is the best and only means of locating hidden water and oil-bearing strata, when once its dumb motions are understood by the individual in whose hands it will turn when he comes or stands over either oil or water; this has been proved to you by Prof. W. F. Barrett, who was appointed by the Royal Society to investigate the divining-rod and its users, in the year 1891 or 1892. I commenced to investigate it in the year 1888 here in Los Angeles county, first for mineral, later for oil and water, and have been on the job ever since. I give credit and commend Prof. Barrett for his honesty; he says the best geologists have failed on the very same ground to find water, where the dowser was successful on the same. But Prof. Barrett attributes the success of the dowser to clairvoyancy (I don't); I find the power is not in the rod; it is in the man who can use it, and only in him, when he understands the rod's dumb motions. The rod is only a means to an end; it is simply the ultimate of what is in the man. It matters not what kind of wood the rod is made of; neither does it cut any figure whether you insulate the man who uses it or not. I have prospected for oil and water and minerals in rubber-tyred autos. and horse and buggy, on railroad trains, and on the desert-freighter; none of them make any difference to me nor to any man; whether he is insulated or not; or the speed he may drive at while he is in search of either oil, water or mineral, if he is the user, only understands the dumb motions of the forked stick he can find any one of the three required, but only one at a time.

"I would say, beware of any oil or water locators who use a magnet to locate either oil, water, gold, silver, copper or tin, and also of those who may tell you how many barrels of oil or inches of water a well will give before a well is put on the pump. These locators are invariably the class known as fakers and ought to be avoided by all means by those who have to foot the bills, whether it is the Government or the Lord of the Manor, a company, or a private individual.

(To be continued.)

THE UNAFLOW STEAM ENGINE.

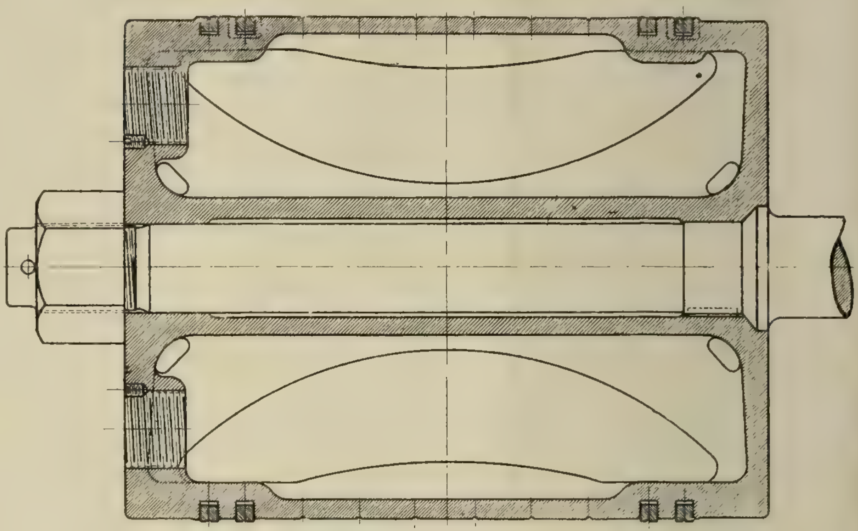
By D. H. Yates.

(Continued from page 230.)

Condensing Plant.

The condensing plant usually adopted is of the jet type, coupled to an Edwards' air pump, but it is not essential that this type of condensing plant should be used, as the Unaflow engine will work equally well with any type of condensing plant, whether jet, surface, or barometric, either worked independently or coupled to the engine. It should be pointed out, however, that the best steam consumption results

should be expected by having the condenser as near as possible to the cylinder, and that the introduction of oil separators or other contrivances in the exhaust pipes is not to be recommended unless abso-

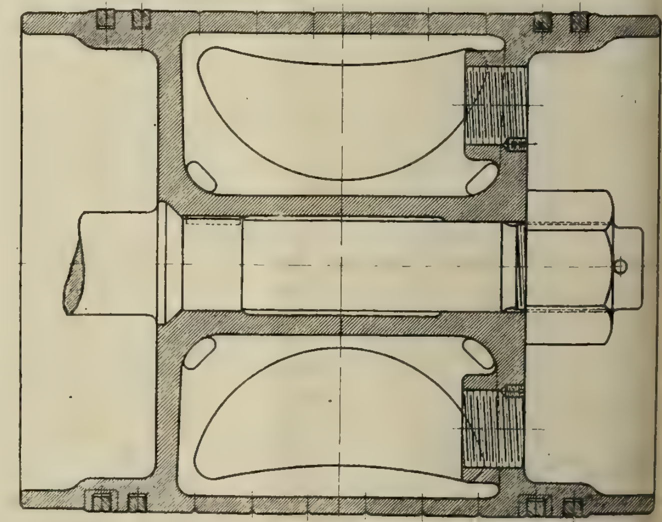


Unaflow Steam Engine.—Fig. 15.

lutely necessary, as they only tend to cause a less effective vacuum in the cylinder unless very particular and minute attention is bestowed upon their arrangement and design.

Piston and Piston Rod.

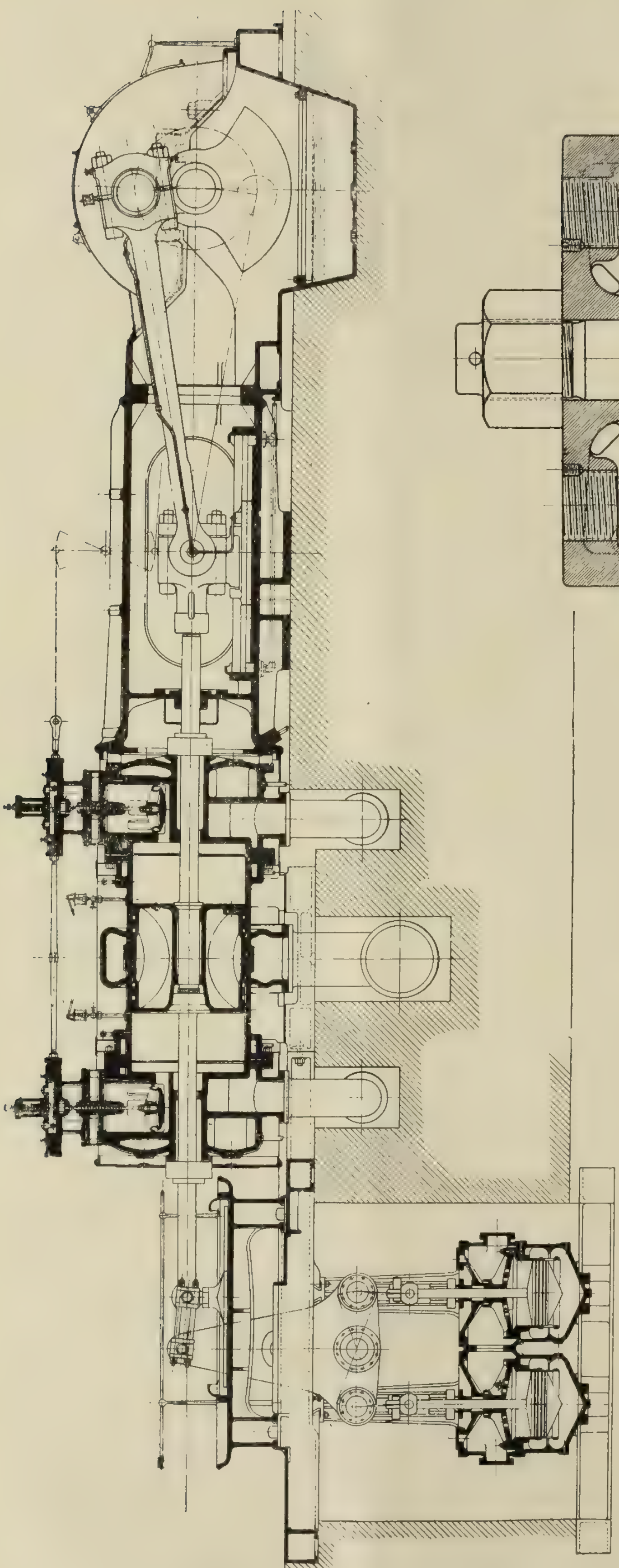
The piston, which is of cast iron, is designed to have a maximum of strength with a minimum of weight, and is of a length equal to nine-tenths of the stroke for reasons previously explained. Fig. 15 shows a section of a piston for a condensing engine with a small clearance space, the piston ends being flat for this purpose. Fig. 16 shows a type of piston



Unaflow Steam Engine.—Fig. 16.

often used in a non-condensing engine, the ends being made concave to provide the additional clearance space required in the case of a non-condensing engine. Other details of design in the two types of piston are essentially the same.

The piston rings are placed near the ends of the



Unaflow Steam Engine.—Fig. 17.

piston, there being two at each end. These are of the well-known Ramsbottom type, turned eccentric. If, when working, the rings turned round in the piston, the ends or joints of the rings would foul the exhaust ports during the passage of the piston, and so cause breakage of the rings, and perhaps of the cylinder. To prevent this a brass stop piece is driven into a slot in the piston whilst cold, there being one stop piece to each ring. The stop pieces are arranged on the bottom of the piston, so that they work over the barrel between the two bottom exhaust ports. The piston is prevented from turning round on the piston rod by means of a key, thus ensuring that the stop pieces are always on the bottom of the cylinder.

All the circumferential edges of the piston and rings are rounded off to facilitate the lubrication of the piston and barrel, this being an important factor in the design of the piston for any type of engine. Lubricating grooves are also turned in the piston at intervals between the rings.

The piston is cast hollow, the core holes being afterwards plugged up. It is secured to the piston rod by means of a nut, and it is customary in the larger sizes of engines to continue it through the back valve box and connect it to a slipper working in a back slide, the rod being cambered to take the weight of the piston without apparent deflection. When the piston is at its greatest velocity, which is approximately the middle of the stroke, it is passing over the cool exhaust ports, which is a decided advantage; also, on account of its large bearing surface, the piston has a low specific bearing pressure. Average piston speeds up to 800 feet per minute are common. Whilst dealing with the piston we will see how it tends to increase the efficiency of the engine in a manner not previously mentioned. In a counterflow engine one source of loss of efficiency is due to leaky valves. The exhaust valve is often leaky, and any loss of steam from this source is a direct loss, as it may get past the exhaust valves without doing any useful work in the cylinder; *e.g.*, when the piston is at the beginning of its stroke. In the case of a Unaflow engine, however, there is no exhaust valve to contend with, and on account of its length and the position of the piston rings the piston is more steam tight than the ordinary piston of short length, any piston leakage at high pressure being compelled to pass two sets of rings and several grooves. By the time that one set of rings has passed the exhaust ports the pressure has been reduced considerably, the remaining set being quite capable of keeping the piston satisfactorily steam-tight. It is, therefore, practically impossible for steam to reach the exhaust ports without doing useful work. Add to this the fact that the steam valves are easier to make steam-tight on account of their small size and more even temperature to which they are subjected, thereby reducing the tendency to warp, and it will be seen that the losses due to leaky pistons and valves are considerably less than we should expect to find in a counterflow engine.

Crosshead, Connecting Rod, and Crankshaft.

For the purpose of explaining the general construction of the Unaflow engine, we will now examine Fig. 17, which illustrates a 1,000 I.H.P. Unaflow engine in section.

The cross-head here shown is of the marine type, with one slipper block only, but the latest tendency is to provide a cross-head of the solid type with adjustable wedge-block and gun-metal steps and two slippers working in bored slides.

The connecting rod has a fork end at the cross-head and a marine end at the crank pin, the crank pin brasses being lined with white metal. The length of the connecting rod from centre to centre is usually $2\frac{1}{2}$ strokes.

The crankshaft is built up, the crank pin being secured in and between two balanced cranks, with a bearing on the outer side of each crank, the latter being of cast steel. The body of the crankshaft carries the flywheel or pulley in the usual manner, and is provided with a back neck pedestal. The outer end of the crankshaft is extended to receive the crankshaft governor.

Trunk and Pedestal Frames.

The trunk frame is of the enclosed type with large side openings covered in, the whole being perfectly oil-tight. The fittings on the trunk frame comprise indicating gear and various oil and drain appliances.

The pedestal frame has a target end bolted to the trunk frame, and two pedestals, one inner and one outer. The bottom of the crank race is made oil-tight, and may be used as an oil well for forced lubrication purposes, and the top is cased in, thus preventing oil splash and acting as a connecting rod and crank guard.

Air Pumps.

The air pumps are of the twin Edwards' type, worked by means of an air pump lever connected to the back cross-head by side links. The arrangement of the back slide is also clearly shown.

(To be continued.)

HYDRO-ELECTRIC POWER IN CANADA.

(Concluded from page 256.)

Cost of Developing a Million Horse Power.

The capital cost of furnishing a million horse power to the City of Toronto, including hydro-electric development at Niagara Falls and all the switching and transforming equipment, together with transmission and distribution lines, etc., etc., would probably be somewhere between 200 and 250 dollars per horse power to deliver electricity to the consumer's houses—this means a capital investment of from 200 to 250 million dollars. This enormous sum, owing to the fact that the plant would be idle for nearly six months out of every twelve, as already pointed out, would, during half of its existence, be earning nothing, and the services of a large number of men would, of necessity, have to be retained throughout the summer months during the non-earning period in order that they might be available when required in the winter.

Thus the capital charges and running costs of such a plant, compared with its earning capacity, would be very heavy. Annual charges on such a plant, covering interest, sinking fund, depreciation, maintenance and operation, would amount to from 22.00 to 27.00 dollars per horse power year. This plant would only be used for heating during a period of

six or seven months, and the consumers would have to pay the charges for the whole year during this period.

Further, there would be no "diversity" factor enabling the supply authority to make any reduction on this cost, as is possible with ordinary existing electricity supply, since the power would be required practically continuously throughout the cold season.

By the word "diversity" is meant that condition of electricity supply whereby, owing to the diverse character of the loads and the times at which they come on and go off, the maximum load on a generating station in a given period, say, one day, is not the sum of the various maximum loads on the station during the day, *e.g.*, the maximum load due ot factories does not necessarily occur at the same time as the maximum load due to street car traffic, nor does the latter necessarily occur at times of maximum load due to lighting. Owing to this state of affairs, supply authorities are enabled to make their charges appreciably lower than they would be able to in the case of a winter heating load, in which the power, as already stated, would be required all the time, and when one person needed extra power all the others would need it at the same time, for the same reason, viz., that the outside temperature had dropped.

Figures and statements such as the foregoing, which are based on incontrovertible facts, should once and for all answer the question in the negative as to whether the great water powers of Canada will ever entirely solve the fuel problem in a climate such as that of Ontario and Quebec.

The Functions of Fuel and Electricity.

The Commission sums up as follows:—

Since, as has been shown, we cannot look forward to using electricity for fully coping with the heating requirements in the cold Canadian winters and must, therefore, continue to rely mainly on fuels, it will be of interest to consider the relation of these two commodities to the needs of the community for mechanical power for industrial and other purposes. It can be readily demonstrated that, of the total energy in fuels, at the present time and under the most favourable conditions possible in the largest and most modern plants, a maximum of 12 to 15 per cent is obtainable in the form of mechanical power. This is only about one-third of the percentage obtainable in the form of heat in the average house furnace and only about one-fourth of that obtainable in the form of mechanical power from the water power of an hydro-electric plant. Moreover, it can be shown that there is no hope of ever getting more than perhaps four or five per cent greater efficiency than this 12 to 15 per cent in converting the energy in fuels into mechanical power. This fact, taken in conjunction with those already given regarding electricity, leads to the conclusion, that so far as is practicable, fuel should be used for heating, and electric energy for mechanical power. This argument regarding electric energy applies whether in relation to motors in factories, etc., or on street cars, electric railways, etc.

True conservation, therefore, lies in using, to the fullest practicable extent, water power for the generation of mechanical power and fuels for heating. Where no water power is available, then the fuels must, of necessity, be used for mechanical power purposes, but this will preferably be done in large electric generating stations, the electric energy from which will be converted into mechanical power by means of electric motors, and again the fuels should preferably be used directly for the purposes of heating without converting their energy first into electricty and then into heat.

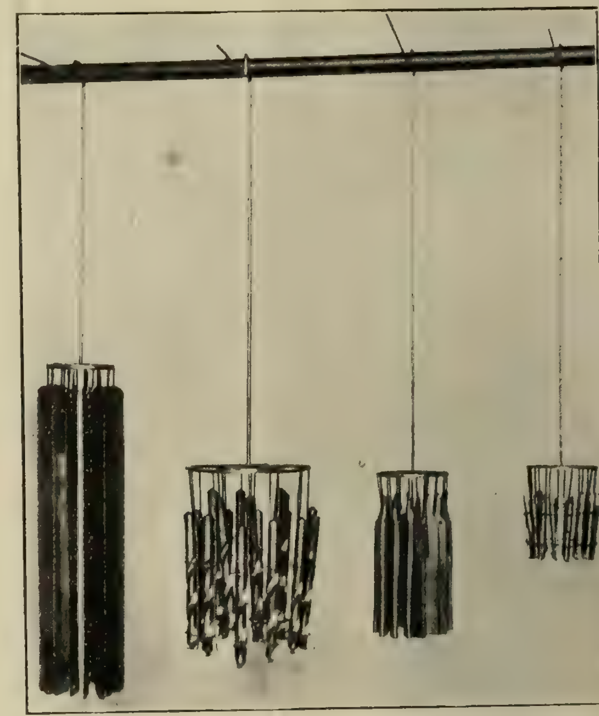
(*Concluded.*)

MULTIPLE TOOL-HARDENING HOLDERS.

[Automatic and Electric Furnaces Ltd., 6, Old Queen Street, London, S.W.1]

There are many various methods of holding articles during the progress of heating and quenching. For large articles such as gear wheels it is quicker and easier to treat each article separately, suspending it in the furnace by a piece of iron wire twisted round the article.

Numerous forms of holders for multiple tool-hardening are designed by users of furnaces them-



Multiple Tool-hardening Holders.

selves. In all instances there are two features which should be borne in mind, viz., that the holder should be of as small dimensions as the nature of the article will permit, and that ample space should be left between the articles, so as to ensure the quenching medium reaching all parts.

In our illustration—kindly supplied by the above firm—the example on the left shows a holder designed to take 16 hack-saw blades, 13 in. × 1 in.; total weight of holder and blades, 3 lb. Following on from left to right are shown a holder for 18 twist drills, $\frac{1}{2}$ in. × $5\frac{1}{4}$ in.; total weight, with holder, $3\frac{1}{2}$ lb.; holder with 16 razor blades, and one with 16 taps, $\frac{1}{4}$ in. × $2\frac{1}{2}$ in.; total weight, with holder, under 2 lb.

Weights of Lengths of Rolled Steel Sections.

Beam 6 in. × 2 in. × 11½ lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	Ft.
0	..	1 0 3·0	2 0 6·0	3 0 9·0	4 0 12·0	5 0 15·0	6 0 18·0	7 0 21·0	8 0 24·1	9 0 27·0	0
1	0 0 11·5	1 0 14·5	2 0 17·5	3 0 20·5	4 0 23·5	5 0 26·5	6 1 1·5	7 1 4·5	8 1 7·5	9 1 10·5	1
2	0 0 23·0	1 0 26·0	2 1 1·0	3 1 4·0	4 1 7·0	5 1 10·0	6 1 13·0	7 1 16·0	8 1 19·0	9 1 22·0	2
3	0 1 6·5	1 1 9·5	2 1 12·5	3 1 15·5	4 1 18·5	5 1 21·5	6 1 24·5	7 1 27·5	8 2 2·5	9 2 5·5	3
4	0 1 18·0	1 1 21·0	2 1 24·0	3 1 27·0	4 2 2·0	5 2 5·0	6 2 8·0	7 2 11·0	8 2 14·0	9 3 17·0	4
5	0 2 1·5	1 2 4·5	2 2 7·5	3 2 10·5	4 2 13·5	5 2 16·5	6 2 19·5	7 2 22·5	8 2 25·5	9 3 0·5	5
6	0 2 13·0	1 2 16·0	2 2 19·0	3 2 22·0	4 2 25·0	5 3 0·0	6 3 3·0	7 3 6·0	8 3 9·0	9 3 12·0	6
7	0 2 24·5	1 2 27·5	2 3 2·5	3 3 5·5	4 3 8·5	5 3 11·5	6 3 14·5	7 3 17·5	8 3 20·5	9 3 23·5	7
8	0 3 8·0	1 3 11·0	2 3 14·0	3 3 17·0	4 3 20·0	5 3 23·0	6 3 26·0	8 0 1·0	9 0 4·0	10 0 7·0	8
9	0 3 19·5	1 3 22·5	2 3 25·5	4 0 0·5	5 0 3·5	6 0 6·5	7 0 9·5	8 0 12·5	9 0 15·5	10 0 18·5	9

Weight of Beam, advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight.	lbs. 0·958	lbs. 1·91	lbs. 2·87	lbs. 3·83	lbs. 4·79	lbs. 5·75	lbs. 6·70	lbs. 7·66	lbs. 8·62	lbs. 9·58	lbs. 10·34	lbs. 11·5	Weight.

Weights of Lengths of Rolled Steel Sections.

Beam 6 in. × 2 in. × 11½ lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	10 1 2	1 0 2 4	1 10 3 6	2 1 0 8	2 11 1 10	3 1 2 12	3 11 3 14	4 2 0 16	4 12 1 18	0
10	1 0 3	11 1 5	1 1 2 7	1 11 3 9	2 2 0 11	2 12 1 13	3 2 2 15	3 12 3 17	4 3 0 19	4 13 1 21	10
20	2 0 6	12 1 8	1 2 2 10	1 12 3 12	2 3 0 14	2 13 1 16	3 3 2 18	3 13 3 20	4 4 0 22	4 14 1 24	20
30	3 0 9	13 1 11	1 3 2 13	1 13 3 15	2 4 0 17	2 14 1 19	3 4 2 21	3 14 3 23	4 5 0 25	4 15 1 27	30
40	4 0 12	14 1 14	1 4 2 16	1 14 3 18	2 5 0 20	2 15 1 22	3 5 2 24	3 15 3 26	4 6 1 0	4 16 2 2	40
50	5 0 15	15 1 17	1 5 2 19	1 15 3 21	2 6 0 23	2 16 1 25	3 6 2 27	3 17 0 1	4 7 1 3	4 17 2 5	50
60	6 0 18	16 1 20	1 6 2 22	1 16 3 24	2 7 0 26	2 17 2 0	3 7 3 2	3 18 0 4	4 8 1 6	4 18 2 8	60
70	7 0 21	17 1 23	1 7 2 25	1 17 3 27	2 8 1 1	2 18 2 3	3 8 3 5	3 19 0 7	4 9 1 9	4 19 2 11	70
80	8 0 24	18 1 26	1 8 3 0	1 19 0 2	2 9 1 4	2 19 2 6	3 9 3 8	4 0 0 10	4 10 1 12	5 0 2 14	80
90	9 0 27	19 2 1	1 9 3 3	2 0 0 5	2 10 1 7	3 0 2 9	3 10 3 11	4 1 0 13	4 11 1 15	5 1 2 17	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	5 2 2 20	10 5 1 12	15 8 0 4	20 10 2 24	25 13 1 16	30 16 0 8	35 18 3 0	41 1 1 20	46 4 0 12	51 6 3 4	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 5 in. × 3 in. × $10\frac{1}{2}$ lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	Ft.
0	..	0 3 21·0	1 3 14·0	2 3 7·0	3 3 0·0	4 2 21·0	5 2 14·0	6 2 7·0	7 2 0·0	8 1 21·0	0
1	0 0 10·5	1 0 3·5	1 3 24·5	2 3 17·5	3 3 10·5	4 3 3·5	5 2 24·5	6 2 17·5	7 2 10·5	8 2 3·5	1
2	0 0 21·0	1 0 14·0	2 0 7·0	3 0 0·0	3 3 21·0	4 3 14·0	5 3 7·0	6 3 0·0	7 2 21·0	8 2 14·0	2
3	0 1 3·5	1 0 24·5	2 0 17·5	3 0 10·5	4 0 3·5	4 3 24·5	5 3 17·5	6 3 10·5	7 3 3·5	8 2 24·5	3
4	0 1 14·0	1 1 7·0	2 1 0·0	3 0 21·0	4 0 14·0	5 0 7·0	6 0 0·0	6 3 21·0	7 3 14·0	8 3 7·0	4
5	0 1 24·5	1 1 17·5	2 1 10·5	3 1 3·5	4 0 24·5	5 0 17·5	6 0 10·5	7 0 3·5	7 3 24·5	8 3 17·5	5
6	0 2 7·0	1 2 0·0	2 1 21·0	3 1 14·0	4 1 7·0	5 1 0·0	6 0 21·0	7 0 14·0	8 0 7·0	9 0 0·0	6
7	0 2 17·5	1 2 10·5	2 2 3·5	3 1 24·5	4 1 17·5	5 1 10·5	6 1 3·5	7 0 24·5	8 0 17·5	9 0 10·5	7
8	0 3 0·0	1 2 21·0	2 2 14·0	3 2 7·0	4 2 0·0	5 1 21·0	6 1 14·0	7 1 7·0	8 1 0·0	9 0 21·0	8
9	0 3 10·5	1 3 3·5	2 2 24·5	3 2 17·5	4 2 10·5	5 2 3·5	6 1 24·5	7 1 17·5	8 1 10·5	9 1 3·5	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	0 8·75	0 1·75	0 2·625	0 3·5	0 4·375	0 5·25	0 6·125	0 7·0	0 7·875	0 8·75	0 9·625	0 10·5	

Weights of Lengths of Rolled Steel Sections.

Beam 5 in. × 3 in. × $10\frac{1}{2}$ lbs. per foot.

Ft	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	9 1 14	0 18 3 0	1 8 0 14	1 17 2 0	2 6 3 14	2 16 1 0	3 5 2 14	3 15 0 0	4 4 1 14	0
10	0 3 21	10 1 7	0 19 2 21	1 9 0 7	1 18 1 21	2 7 3 7	2 17 0 21	3 6 2 7	3 15 3 21	4 5 1 7	10
20	1 3 14	11 1 0	1 0 2 14	1 10 0 0	1 19 1 14	2 8 3 0	2 18 0 14	3 7 2 0	3 16 3 14	4 6 1 0	20
30	2 3 7	12 0 21	1 1 2 7	1 10 3 21	2 0 1 7	2 9 2 21	2 19 0 7	3 8 1 21	3 17 3 7	4 7 0 21	30
40	3 3 0	13 0 14	1 2 2 0	1 11 3 14	2 1 1 0	2 10 2 14	3 0 0 0	3 9 1 14	3 18 3 0	4 8 0 14	40
50	4 2 21	14 0 7	1 3 1 21	1 12 3 7	2 2 0 21	2 11 2 7	3 0 3 21	3 10 1 7	3 19 2 21	4 9 0 7	50
60	5 2 14	15 0 0	1 4 1 14	1 13 3 0	2 3 0 14	2 12 2 0	3 1 3 14	3 11 1 0	4 0 2 14	4 10 0 0	60
70	6 2 7	15 3 21	1 5 1 7	1 14 2 21	2 4 0 7	2 13 1 21	3 2 3 7	3 12 0 21	4 1 2 7	4 10 3 21	70
80	7 2 0	16 3 14	1 6 1 0	1 15 2 14	2 5 0 0	2 14 1 14	3 3 3 0	3 13 0 14	4 2 2 0	4 11 3 14	80
90	8 1 21	17 3 7	1 7 0 21	1 16 2 7	2 5 3 21	2 15 1 7	3 4 2 21	3 14 0 7	4 3 1 21	4 12 3 7	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	4 13 3 0	9 7 2 0	14 1 1 0	18 15 0 0	23 8 3 0	28 2 2 0	32 16 1 0	37 10 0 0	42 3 3 0	46 17 2 0	

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ENGINEERING APPOINTMENTS OPEN.

TRADE ITEMS, NOTES, &c.

Messrs. Rowland Willis and Co., of 141, Fenchurch Street, London, E.C. 3, announce that their machine-tool and engineering business, hitherto conducted by Mr. A. F. Willcocks, will in future be carried on under the style of Messrs. Arthur Willcocks and Co., at the same address.

The educational authorities at Coventry are proposing to establish a technical institute at a cost of over £100,000. A separate fund has been started with a subscription of £5,000, which it is hoped the manufacturers of the city will raise to £50,000, to be spent mainly in equipment for trade instruction.

The output from the Clyde shipyards in February has aggregated 27,522 tons, consisting of 12 vessels, making the total for the first two months of the year 23 vessels of 42,105 tons. No figures were available during the four years of the war, but in February, 1914, 19 vessels were launched, aggregating 51,340 tons.

The Hydraulic Engineering Co. Ltd., Chester, has secured a contract for the gate machinery required by the Mersey Docks and Harbour Board for operating the south and middle lock gates of the 90 ft. passage between the Gladstone and Hornby Docks at Liverpool.

From tests applied by the Boston Transit Commission as to the respective values of painted and unpainted steel rods for reinforcement, it appears that the bonding strength of the painted rods was much less than that of any of the plain unpainted rods. The best bonding strength of any of the painted rods was only about one-fifth that of the plain rods. The rods tested were ¾ in. cut in 24 in. lengths.

Messrs. J. Dampney and Co. Ltd., of London, Cardiff and Liverpool, have recently acquired the Cleveland Paint Works at Middlesbrough. These works are being enlarged and reorganised, and electrically-driven machinery is being installed. This addition to the firm's Cardiff works will enable it to deal with a larger output of material, and to cater for the needs of a much larger circle of customers, particularly those in the North-Eastern district.

It is known that an addition of a small quantity of sodium or magnesium to lead hardens the metal considerably. If tin be added to either of these alloys its brittleness is somewhat diminished, and its resistance to chemical action accordingly increased. According to *Metall un Erz*, an alloy of soft lead and magnesium, which, in moist air, is slightly attacked on the surface, is proof against such action when tin is added. The proportion of sodium or magnesium added should not be greater than 4 per cent.

The Future of the Gas Engine.—In his paper read on March 19th, before the Royal Society of Arts, Sir Dugald Clerk, K.B.E., D.Sc., F.R.S., pointed out that the thermal efficiency of the internal combustion engine is much higher than that of the most economical steam turbines. Gas engines use town's coal gas with a brake efficiency of 30 per cent of the heat combustion of the gas, and they also use blastfurnace gas, coke-oven gas, and inflammable gas produced from waste wood, chips and peat. These engines, he said, are most important factors in securing fuel economy, and they should be allowed freedom to develop in competition with steam engines of all types as heretofore.

When a beam, the weight of which can be neglected, has one end built into a wall and the other end loaded, the flexure of the beam is accompanied by a twist of successive sections with respect to each other, unless these sections are symmetrical. The relation between the flexure and torsion has been worked out for beams of certain simple sections by Mr. A. W. Young, Miss E. M. Elderton, and Professor K. Pearson, in a Draper's Company research memoir recently published. Some of the conclusions have been verified experimentally, and the authors hope that the research will serve as a first step towards the understanding of the relation between flexure and torsion in propeller blades.

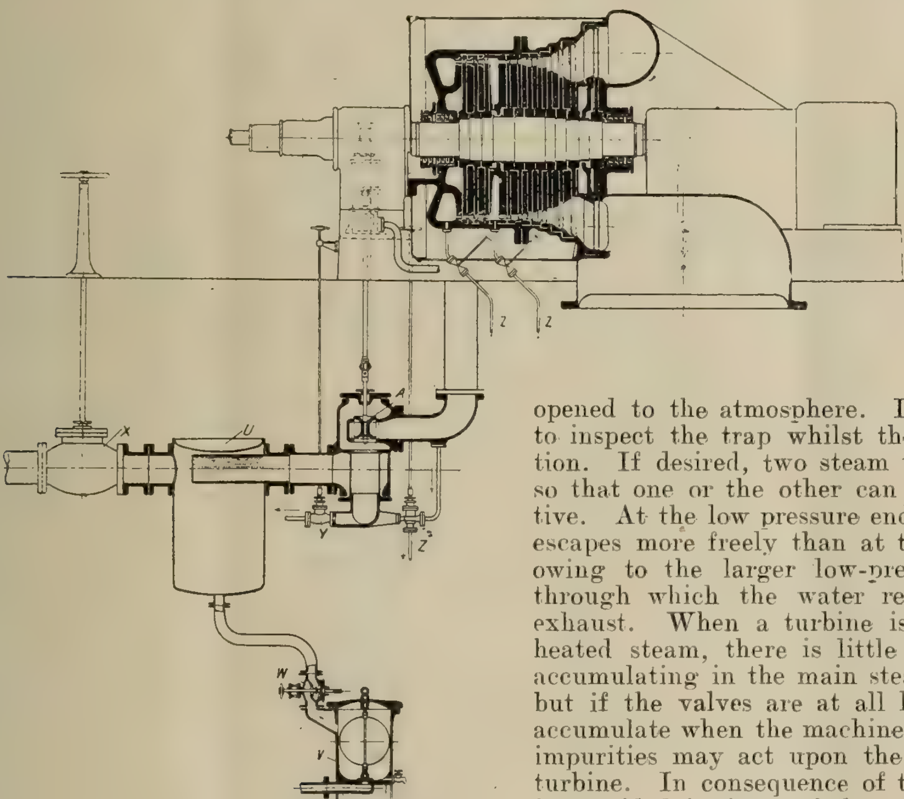
MODERN STEAM TURBINES.

By J. Humphrey.

(Continued from page 233.)

Oerlikon Turbine.

A turbine which possesses a number of special features, and which has not yet been described in this series of articles, is the Oerlikon turbine, built by the Oerlikon Co., of Switzerland, the Company's London representative being Mr. G. Wüthrich, of Oswaldestre House, Norfolk Stret, Strand, W.C. 2. A section of this turbine is shown in the upper part of Fig. 81, from which it will be seen that it is an impulse machine of the Rateau variety, having revolving discs and fixed diaphragms. The rotor revolves in two main bearings and the neck glands at the ends of the machine are of the carbon ring pattern. In accordance with usual practice the governor, which is of the throttle-valve type, is mounted on a vertical shaft at the live steam end, the shaft being driven by means of a worm on the turbine spindle. The clearances between the casing and running discs, and between the discs and diaphragms are liberal, amounting to from ⅛ to ¼ of an inch. Very elaborate precautions have been taken to ensure reliability and safety under all conditions, and it is in this respect that the Oerlikon turbine differs mainly from other turbines of the disc and diaphragm pattern. Before proceeding to deal with the special safety devices, however, it may be pointed out that these turbines have proved themselves to be very economical, and have met with high appreciation in this country.



Steam Turbines.—Fig. 81.

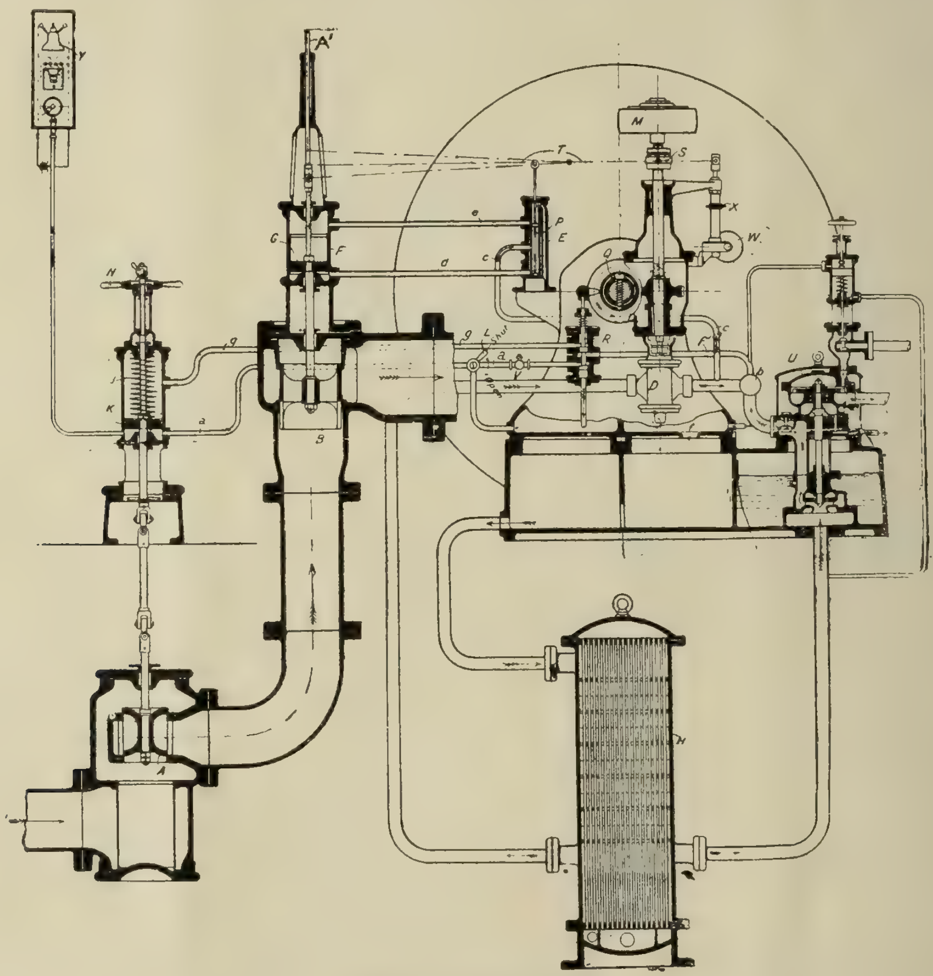
Drainage System.

Considerable attention has been devoted to the drainage of these turbines with a view to avoiding internal corrosion. To avoid all access of water from the boiler into the turbine, a large water separator as shown at U, Fig. 81, is interposed in the steam pipe immediately in front of the main stop valve A and the pipe coupling up this strainer with the turbine is perforated only on the upper side as shown dotted, the lower part and butt end being solid, with the result that all water falls to the bottom of the separator from whence it passes into the steam trap V. This trap is provided with a ball float which opens a valve at the bottom of the trap when the water reaches a certain level. In the pipe leading to the steam trap there is also a hand-operated valve W. By closing this valve, the trap can be put out of action, and the discharge from the separator opened to the atmosphere. It is therefore possible to inspect the trap whilst the turbine is in operation. If desired, two steam traps can be provided so that one or the other can always remain operative. At the low pressure end of the turbine water escapes more freely than at the high pressure end, owing to the larger low-pressure steam passages through which the water readily passes into the exhaust. When a turbine is working with superheated steam, there is little if any risk of water accumulating in the main steam pipe or elsewhere, but if the valves are at all leaky, water is apt to accumulate when the machine is at a standstill, and impurities may act upon the interior parts of the turbine. In consequence of this, a second valve X is provided in front of the main stop valve A, and when the turbine is stopped both these valves are closed. Between these valves X and A is also a drain-cock Y, and when the turbine is shut down this cock is opened. Hence, if the valve X is leaky the leakage steam will not pass through the valve A into the turbine, but through the valves Y and W into the atmosphere. In addition to these drainage arrangements, drain pipes are also fitted to the high-pressure part of the turbine as shown at Z, and after the turbine is shut down the valves in these drain pipes are opened so that any condensed water that remains in the turbine is free to run away.

Governor and Safety Gear.

Special arrangements are fitted to the Oerlikon turbine with a view to preventing accidents arising as the result of excessive speed and also as the result of the lubricating system failing. A view of the governor

gear and its safety devices is shown in Fig. 82. From the main valve A the steam passes to the regulating valve B, which is controlled by oil under pressure, the admission of steam into the turbine being controlled by throttling. If the full admission pressure is attained and there is still a demand for more load, a second overload valve is opened which admits live steam to the turbine in front of the first two revolving discs so that the turbine receives full-pressure steam a little nearer the exhaust than usual. In other words, at periods of overloads the turbine is governed on the by-pass principle, as described in an earlier article. The by-pass valve is not shown in Fig. 82, but it is to be very reliable, it has been deemed advisable to provide safety gear which shuts the turbine down automatically in the event of the oil supply failing. The main valve A is closed by the action of the spring J and is opened by oil admitted beneath the piston K at a pressure of about 60 lbs. per square inch, but the strength of the spring J is such that the valve immediately closes in the event of the oil pressure dropping to 22 lbs. per square inch. Hence, if the oil pressure fails or drops to an unsafe value the turbine immediately stops. To shut the turbine down by hand when the load has been taken off the generator, the three-way cock L is turned through 90 deg., and the oil under pressure flows



Steam Turbines.—Fig. 82.

situated on top of the turbine and is coupled up through a horizontal lever to the vertical rod A^1, so that when the rod moves in an upward direction above a certain point, the overload valve automatically opens. Oil under pressure for lubricating the bearings and also actuating the governor gear is provided by means of a small oil pump of the gear-wheel pattern, this pump being coupled to the lower end of the governor spindle, as shown at D. On leaving the bearings and governor-gear, the oil passes by way of the base of the turbine and a strainer into the cooler H, through which cooling water is caused to circulate. Although in practice the oil pumps fitted to these turbines have been found away from under the piston K into the base of the turbine and the spring J closes the valve A.

Although the main regulating valve B is controlled by oil under a fairly high pressure, the actual amount of work the governor M is called upon to perform is very little indeed. All the governor has to do is to actuate the small relay piston P, which according to its position admits oil either above or below the piston G in the cylinder F and the valve opens or closes accordingly. In the unlikely event of something wearing or breaking, which would put the pump D out of action, the oil pressure under the piston would of course drop, and the valve A would be closed by the spring J, hence it will be seen that

the machine is immune from troubles arising from the want of oil. The emergency governor which shuts off the supply of steam to the turbine in the event of the speed becoming excessive, is shown at Q, it being a small spring-controlled weight inserted in the main turbine shaft at right-angles to the axis. When the speed of the turbine exceeds a certain value this weight moves outwards as the result of centrifugal force, and it comes into contact with a small piston R. The movement of this piston, caused by the spring-controlled weight, has the effect of transferring the oil in the cylinder from under the piston K to above it, and the valve A closes, this occurring when the shaft speed attains a value about 15 per cent above normal. A second safety device is also provided just below the oil pump D, and this comes into operation in the event of the speed reaching a value 20 per cent above normal. The driver must see before starting the turbine that the three-way cock L on the oil pipe *a* is closed. Obviously the valve A will also be closed, and during the starting period oil is supplied to the bearings and control arrangements of the turbine by means of the small auxiliary pump U which, in this particular case, is driven by a small steam turbine. The course of the oil through this pump is clearly shown by the arrows. Having left the pump, the oil passes by way of the pipe *b* to the turbine and generator bearings, and also through the pipe *c* to the controlling cylinder E. It then passes through the pipe *d* to the regulating cylinder F. When the oil pressure has been established by setting the auxiliary oil pump U in motion, the oil acting on the underside of the piston G in the cylinder F forces the former upwards, and the regulating valve B is opened. On easing the main stop-valve A off its seat, the turbine is then warmed up in the usual way, and when the casing has been made hot the valve A is opened sufficiently to cause the shaft to revolve. As the speed rises, a point will of course be reached at which the controlling governor comes into action, when the upward movement of the governor sleeve actuates, through the medium of the lever T, the piston of the controlling cylinder E, with the result that oil passes through the pipe *e* and enters the regulating cylinder above the piston G, the oil beneath the piston passing away through the pipe *d*. By means of the rod T the controlling piston P is then brought back into its intermediate position. The auxiliary pump U can then be put out of action, for by this time the speed will have reached the value at which the pump D will supply the oil. On full speed being reached, the three-way cock L is opened so as to charge the cylinder F with oil, this cock being of course left open all the time the turbine is at work. A non-return valve V is fitted in the pipe *a*, and, as this valve only allows a small amount of oil to pass, the main stop-valve is opened gently and without jerk.

(*To be continued.*)

The contracts for building the first two new units for the hydraulic development of Niagara River for the Hydro-Electric Power Commission of Ontario have been placed with the American house of Wellman, Seaver and Head Ltd., of London. These units are to develop 52,500 H.P. each, and will be the largest which have yet been installed.

MOTORCYCLE DESIGN.*

By D. S. Heather, B.Sc.

After having been diverted for four years from their normal business, the motorcycle manufacturers are reverting to the production of their peace-time output, in face of a demand which shows every prospect of improving even on the phenomenal boom of 1914. The higher wages justly obtained by industrial workers during the War have added many thousands to the prospective purchasing public, and in addition, the proved usefulness of the motorcycle for War purposes has induced many people to consider the purchase of a machine, who formerly looked on the motorcycle as nothing better than a toy for the mechanically-minded young man. Unfortunately, however, the four years of War effort have necessarily been four years of stagnation in design, so that many manufacturers find themselves compelled to offer the public in 1919, what are really nothing more than their 1914 and 1915 models. It may reasonably be anticipated, however, that the 1920 season will see many new designs placed on the market, an consequently the period between the spring and autumn of this year will be a period of great activity in the designing departments of the English motorcycle factories

It is hoped that the activities of this Institution will assist the progress of scientific design, by providing opportunities for full discussion of the various problems involved in motorcycle design and by bringing into personal contact all those who are interested in the engineering side of the industry. It appears essential, however, that before consideration is given to the lines along which design should progress in the future, a careful investigation should be made of the position which design has reached at the present moment. It is little use starting out blindly to progress unless the exact location of the starting point is known, as without this knowledge it is quite likely that progress would be made in an entirely wrong direction. It is the author's purpose in this paper, therefore, to examine present-day motorcycle design with a critical eye, and to point out where, in his opinion, it falls short of perfection, and where improvement is most urgently needed. It is perhaps desirable to explain that as the author is not engaged in the motorcycle industry, he is not prejudiced in favour of any particular design, his view-point being purely that of a keen motorcyclist whose everyday efforts are concerned with the manufacture of four-wheeled motor vehicles. It must also be pointed out that in a paper of this type it is only possible to deal with the design of the average machine. Many of the imperfections mentioned have doubtless been overcome in individual designs; the author trusts that in such cases the responsible designers will realise that considerations of time and space have made it impossible to mention individual points of excellence which are not common practice.

The modern motorcycle undoubtedly provides the most economical, and at the same time the most speedy form of mechancial road transport known. Improvement has been rapid during the last ten years, but it has mainly been directed towards

* Abstract of a Paper read before the Institution of Automobile Engineers.

improving the performance capabilities of machines. Trials, races, and hill-climbs have assisted to make the motorcycle capable of going anywhere that a car can go, and indeed, a good sidecar outfit is now capable of working in places where a fourwheeler could not be used. This is a vastly better state of affairs than existed, say, in 1909, before the general adoption of change speed gears had made the motorcycle capable of use in really rough country. Nevertheless, the motorcycle is still a dirty, uncomfortable, and unreliable mount. In fine weather, on good roads, and in the hands of a skilled rider who delights in making adjustments, it is reasonably satisfactory, but in bad weather, on war-time roads, and in the hands of a rider who has no time to give the machine much attention, its defects quickly become apparent. That the average motorcycle is dirty, no one can deny. There has been practically no improvement in the mudguarding of the front wheel for some years, and it is still necessary to fit special leg shields, if the legs and feet of the rider are to be at all reasonably well protected, and as these are afterthoughts, they do not harmonise with the general design of the machine. Such shields, of course, do not protect the machine itself from mud or dirt, and can therefore only be considered as temporary makeshifts. A considerable amount of experimental work is necessary to develop a really efficient system of front mudguarding, and success in this direction would be a great improvement from the rider's point of view, as it would remove the necessity for the use of special leg coverings, which are usually unsightly, and are always a nuisance. In addition, much more attention should be paid to the prevention of oil leaks from the mechanism, or preferably to the enclosure of the whole engine and transmission, so that if oil leaks do occur they will not make the exterior of the machine oily or greasy, and stain the rider's clothes. If the mechanism were enclosed it would have the added advantage of making the whole machine much easier to clean, and would reduce what is at present a four-hours' job, if it be done properly, to the work of perhaps half-an-hour.

That the average motorcycle is uncomfortable on bad roads, is also generally admitted, and of late much attention has been paid to the problems involved in attempts to insulate both rider and machine from road shocks. The majority of those concerned, however, consider the modern machine to be reliable, and it is certainly a fact that there is now very little danger of serious roadside breakdowns troubling the owner of a new machine. In that sense the motorcycle is reliable. When it is considered, however, that in order to keep a machine in reasonable condition, it is necessary to spend 50 per cent more time in making adjustments in the garage than is actually spent in riding, it is evident that even the best of modern English machines cannot yet be said to have achieved complete reliability. A good modern car will run for at least the first five thousand miles without the need for any adjustment arising, but no motorcycle can do a thousand miles under similar conditions without a considerable amount of attention if its road performance is not to suffer. The purchaser requires a machine which will give as good service as a car; he wants to be able to run it without attention other than lubrication, for a really considerable mileage. He wants to be assured that after a week-end run of 250 miles he will not have to sacrifice the whole of his spare time for a week in order to get the machine back into tune again. If motorcycle designers will realise this failing and make their new machines as trouble free as a good car, they will have made a great step forward.

The motorcycle, too, is not nearly as durable as it should be. As a general rule its bearings are working under high specific pressures, and they are frequently improperly lubricated, so that wear soon develops, and after ten thousand miles a complete overhaul is required, with the replacement of numerous parts, particularly in the engine. Careful design, with more adequate bearing surfaces, proper lubrication systems, and protection from dust and mud will doubtless improve matters in the future. Weight is another point to which attention might well be given. The trend of design has gradually increased the weight of machines, until a 500c.c. roadster which used to weigh 190lb. now weighs 260lb. The method adopted to obtain reliability, in the past, has frequently been to pile on metal at the faulty place until breakages no longer occurred, when by reasonable design reliability might have been obtained without any increase of weight. The author hopes, then, that future designs will provide motorcycles which are cleaner, more comfortable, more reliable, more durable, and which weigh less than those of current types. In the following notes detailed consideration is given to the design of the various components, with a view to indicating some of the troubles to which they are at present liable and the direction in which progress in design is required.

(*To be continued.*)

DESIGN AND MECHANICAL EQUIPMENT OF OVERHEAD CRANES.

By H. Thornton.

(*Continued from page 216.*)

Compensating End Carriages.

These are used on heavy cranes, where the single wheel pressures would be too great. By this method we usually get double the number of track wheels, and the design is such that the load is equally divided over all the wheels. Three designs are diagramatically shown in Figs. 10, 11, and 12. No matter which form of end carriage is used, the design must be arranged so as to admit of the easy removal of any wheel and axle.

Longitudinal Travelling Gear.

The motor for this drive is best placed near the centre of the span, and preferably fitted with an extension shaft to reduce the shock due to sudden starting. It is surprising what a difference this extension shaft makes to the life of the gearing, motor, bearings, etc., the longer the motor extension shaft is and the better, within reason, of course. On the end of this shaft is the motor pinion, which gears with a wheel on the cross shaft. The latter extends the full length of the span, and the wheel should be in the centre of the span or as near as possible. At each end of the cross shaft is a pinion gearing with a wheel secured to the track wheel or the track wheel axle.

Horse Power of Motor.

The horse power of the travelling motor can be calculated by quite simple methods, or, a considerable time can be spent in going into the coefficients of journal and rolling frictions; ratio of diameter of travelling wheels to diameter of axles; resultants of forces acting; forces required to accelerate the

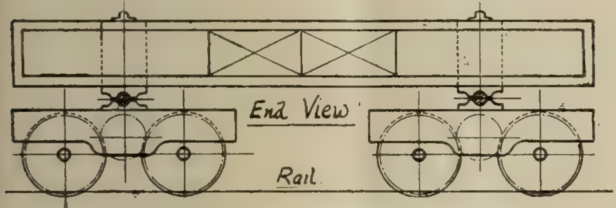


Fig. 10.—Design and Equipment of Cranes.

revolving parts of the drive; tractive effort required to overcome the inertia or flywheel effect; the wind pressure if the crane has to work in the open air, etc., etc.

In calculating the brake horse power of the motor by the simple method, it is necessary to assume a tractive effort of a certain amount per ton of moving load. Thus, suppose that a crane fully loaded weighs 60 tons and travels at the rate of 250 ft. per minute, and a tractive effort of 40 lbs. per ton is assumed, and the mechanical efficiency of the gearing is 75 per cent, then the broke horse power would equal

$$= \frac{40 \times 60 \times 250}{0{\cdot}75 \times 30{,}000} = 24.$$

Travelling Gear.

The usual position for the travelling gear is between the main and auxiliary girders. Some

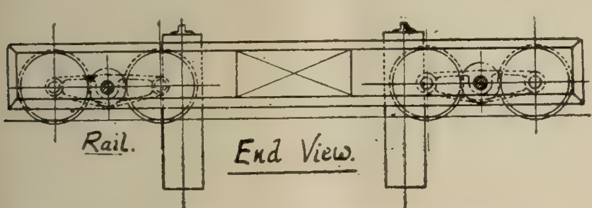


Fig. 11.—Design and Equipment of Cranes.

makers place the whole of the travelling gear on the top of the girders, as shown in Fig. 13. Others place the gear inside the space between the main and auxiliary girders and secure the motor to the web of the main girder, which is then out of the way and compact, and also leaves the platform on the top free from obstruction. The gear is better placed on the top where it is much more acccessible, and everything can be handled from the platform.

The Crab.

In an overhead crane it is usual for the load to hang from a crab, which runs backwards and forwards on rails secured to the tops of the two main girders. This crab carries the lifting and traversing gear, each gear being entirely independent of the other. The great difference in appearance of electric crabs lies mainly in the design of the framing. Some firms use crab frames made of cast iron, others use frames built up of steel channels and joists, and others again use steel-plate sides connected together by channels or large angles.

Cast-Iron Frames.

Cast-iron frames are practically universal in America. They are most elaborate in design, embodying oil-bath gear cases, etc., nearly all the gears being totally enclosed. The cross-channels, which carry the motors, gears, brakes, etc., are made of cast iron. This type of crab is particularly adaptable to standardisation.

Steel Frames.

With this type there are a certain number of advantages, one of these being the greater depth obtained with the plate than a channel or joist, so that advantage can be taken of this depth by fixing the bearing brackets to the side of the plate, thus getting a much bigger bearing surface than is the case when fixing a bearing bracket on the top of a channel or joist. One disadvantage is the absence of lateral stiffness in a long side plate, which is not reinforced by angles along the edges. When this reinforced type is used it is equivalent to using channels or joists, the main difference being the greater depth obtainable.

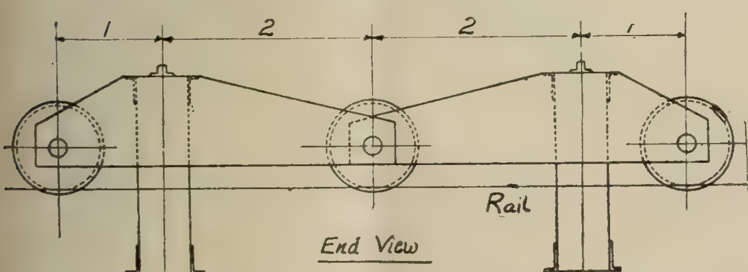
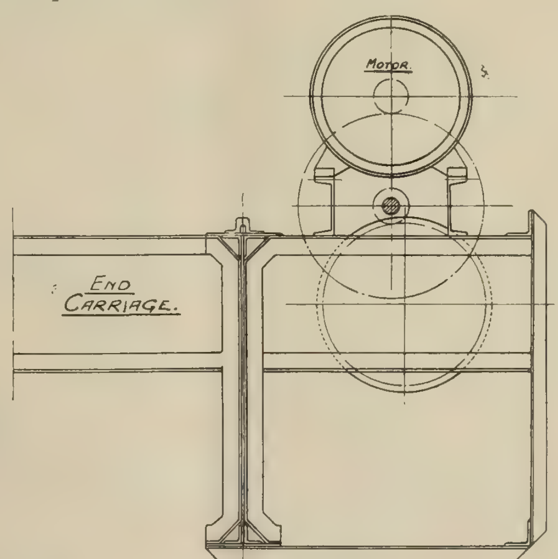


Fig. 12.



Design and Equipment of Cranes. Fig. 13.

Regarding the plate side type, without angle reinforcements, some firms consider it wise to tie all the brackets carrying the various shafts together, or as many as can conveniently be tied together.

This is satisfactory if swivel bearings are not used. It is essential in the channel or joist type of crab frame for as many of the bearings to be tied together as possible, as these fit on the top of the channels or joists, and not on to the side. There is

one large crane firm which makes a speciality of separate bearings in conjunction with the plate-side type of crab. This is the better way, as each of the brackets is fastened to the side of the plate by at least four machined bolts. The fact of tying the bearings together will not make much difference, bearing in mind that swivel bearings are used.

Channel or Joist Frames.

The channel or joist type of crab frame is built in the form of a rectangle, and usually the tops of the channels and joists are on the same level with the motors, gearing, shafts, brackets, and hoisting barrel all being placed on the top of the frame. This makes a very neat, simple, compact, and accessible crab, and any shaft, together with its gearing or barrel, can be lifted straight out without any threading through bearings, wheels, etc., as in some crabs.

Slow-Speed Motors.

Slow-speed motors are used in crane work, the revolutions per minute rarely exceeding 600 or 700; so that there are not many reductions of gearing, depending on the size of crane.

Spur Gearing.

Spur gearing is usually used in this country, but on the Continent worm gearing is almost universally used for the first reduction, and the rest spur gear. In some cranes all the gears are of the worm type, this being brought about mainly by the high efficiencies obtained from well-designed multiple-threaded machine-cut worm gears.

Friction Losses.

If properly made the friction losses in such gearing are exceedingly small. Efficiencies of 92 to 96 per cent are not uncommon for gears having a speed reduction of 20 to 1, and for gears having a speed reduction of 60 to 1, an efficiency of about 87 per cent can be obtained. The worm-wheel rim should be made of phosphor-bronze, with a cast-iron or cast-steel centre and the worm of forged steel, hardened and ground, the whole of the gear being enclosed in a cast-iron oil-bath gear case.

(To be continued.)

HEAT APPLIED TO ENGINEERING.

By Prof. W. W. Haldane Gee, B.Sc., M.Sc.Tech.

(Continued from page 205.)

Graduation of Indicators.

Pyrometer measuring instruments are often provided with two scales, one for millivolts, and the other for Centigrade or Fahrenheit degrees. In the latter case the graduations can only be used with a particular type of thermo-junction and a fixed resistance of leads. The millivolt graduations, on the other hand, can be used with any thermo-junction which follows a known law, or for which a calibration curve has been provided, if a certain definite resistance is always included in the circuit. If there be a change of resistance, as for example, by altering the length of the leads, an error will be produced. How this is produced will now be explained.

Let G be the resistance of the instrument.
,, R ,, ,, ,, external wires.
,, E ,, voltage to be measured.
,, V ,, ,, at the terminals of the instrument.

We have for the current—

$$C = \frac{E}{G+R} = \frac{V}{G},$$

hence

$$E = \frac{G+R}{G} V.$$

Example 1.—Find the voltage at the terminals of a voltmeter of resistance 15 ohms when connected with a 2-volt cell of 5 ohms resistance.

Answer.

$$V = \frac{G}{G+R} E = \frac{15}{15+5} 2 = 1{\cdot}5 \text{ volts},$$

hence the voltmeter will read 0·5 volt lower than the electromotive force of the cell.

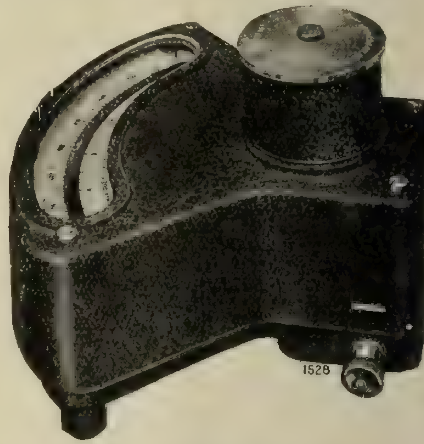


Fig. 34.—Portable Millivoltmeter (Cambridge Scientific Instrument Co.).

Example 2.—Calculate the percentage error in measuring volts when the resistance of a voltmeter is 99 times that of the external circuit.

Answer.—

$$V = \frac{99}{99+1} E, \text{ or } V \text{ is one per cent less than } E$$

The change of the external resistance may be due to the rise of the resistance of the thermo-junction

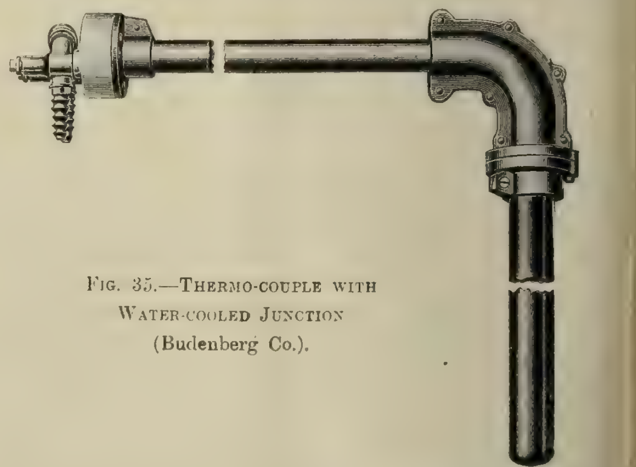


Fig. 35.—Thermo-couple with Water-cooled Junction (Budenberg Co.).

or the leads owing to an increase of temperature. It will be difficult to estimate the amount of this change, but it will cause a small error providing that the resistance of the voltmeter is sufficiently high compared with the rest of the current.

Example 3.—Assuming that the resistance of the

voltmeter and the electrical pressure remain constant, find the value of the resistance of the instrument when a change from 2 to 3 ohms in the external circuit lowers the pressure by $\frac{1}{2}$ per cent.

Answer.—

$$\text{With 2 ohms } V = \frac{G}{G+2} E,$$

$$\text{,, 3 ohms } \frac{99 \cdot 5}{100} V = \frac{G}{G+3} E,$$

hence $G = 197$ ohms.

The last example shows the importance of a high resistance voltmeter. By careful design milli-voltmeters may be made with a resistance of 1,000 ohms. Such an instrument is shown by Fig. 34 with a resistance of about 35 ohms per millivolt and is designed whenever great sensitiveness and accuracy is essential. It has a single jewelled bearing.

Cold Junction Corrections.

When a thermo-electric outfit is calibrated the cold junction is kept at some constant temperature, but in use it may be at some other temperature, and a correction will be necessary. As this cannot always be accurately ascertained it is better to avoid its necessity. With base-metal couples where the cost of wire is not an important consideration, the cold junction may be brought to a place of constant temperature. This may be secured by the use of ice within a thermos flask, which will keep the ice from melting for a long period. Another way is to enclose the junction in a tube around which steam passes, or the junction may be jacketed and kept at a constant temperature by the circulation of water from the town mains. Still another method is to bury the cold junction in the earth. In each case it is important that the junction be kept perfectly dry. Should it get wet voltaic currents will be produced of much greater voltage than those due to the thermo-electric effect.

Fig. 36. Thermo-couple with Thermometer. (Budenberg Co.)

Fig. 35 is an arrangement suitable for use with a cold water supply.

If none of the above methods be applied it will be advisable to have a thermometer attached to the cold junction, as shown in Fig. 36. To calculate the correction it will be necessary to know the thermo-electric law. If the pressure is simply proportional to the difference between the temperature of the hot and cold junctions, then the calculation is quite easily made. To simplify the explanation, let the cold junction be first at 0 deg. C., then when the temperature of the hot junction is raised to T deg. we have

$$E = kT$$

where E is the pressure and k is some constant. If in use the cold junction is kept at some other temperature, say 20 deg. C., then

$$E_1 = k\ (T - 20)$$

where E_1 is the pressure now measured on the milli-voltmeter. This will be less than the required value E. To find the difference between these values, let the cold junction be at 0 deg. and the hot junction at 20 deg. Then

$$E_2 = k \times 20$$

but $E - E_1 = kT - k\ (T - 20) = k \times 20 = E_2$ or the required value of $E = E_1 + E_2$.

With an indicator having a scale of degrees it is only necessary to add the cold junction temperature to that indicated by the pointer on the scale. Another method will be to set the pointer not at 0 deg., but at the temperature of the cold junction, then no addition will be necessary to the scale readings.

If a straight line law is not followed the calibration curve may be used to find the value of the correction.

Example 1.

A thermo-couple following a straight line gives 40 microvolts per degree above 0 deg. C., find the temperature which corresponds to 4,000 microvolts when the cold junction is at 15 deg. C.

Answer.—Apparent temperature $\frac{4000}{40} = 100$ deg.

Real temperature $100 + 15 = 115$ deg.

Exercise 2.—The calibration curve of a thermo-electric couple which does not follow a straight line has been obtained. The vertical scale is in millivolts and the horizontal one is in degrees Centigrade. The curve

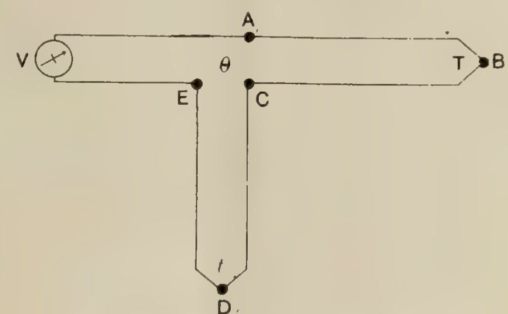


Fig. 37.—Method of Compensation.

starts from zero on both scales. On measuring a temperature with the cold junction at 200 deg. the pressure indicated 18 millivolts, what is the temperature T of the hot junction ?

Answer.—At 200 deg. the curve gave 1·5 millivolts, so that the pressure with T and the cold junction at 0 deg. will be 19·5 millivolts. The temperature T corresponding to this on the curve was found to be 1,250 deg. Cen.

When the indicator reads in degrees it has been shown by P. D. Foote (*Bulletin Bureau of Standards*, Vol. IX., page 553) that the following rule will give the correction to be added to the observed temperature :—

$$\frac{\text{Voltage of junctions at 0 deg. and cold junction temperature}}{\text{Rate of variation at indicated temperature of voltage with temperature.}}$$

Exercise 3.—The equation to the calibration curve of a thermo-junction is :—

$$E = 15\,T + 0 \cdot 01\,T^2.$$

It is required to find the correction for an indicated temperature of 1,000 deg. Cen., when the other junction was at 30 deg. Cen.

ANSWER.—Pressure for 0 deg. and 30 deg.—

$$= 15\ (30) + 0{\cdot}01\ (30^2) = 459 \text{ microvolts.}$$

$$\frac{d\,E}{d\,T} = 15 + 0{\cdot}02\ T$$

$$= 15 + 0{\cdot}02\ (1{,}000) = 35$$

$$\text{Correction} = \frac{459}{35} = 13\,^\circ\,1.$$

Hence, true temperature = 1013·1.

Use of Compensating Couples.

Various devices have been introduced to avoid the use of long and expensive wires of the noble metals. Some of them depend on the use of cheaper materials which follow the same thermo-electric law as platinum—platinum alloy couples. Fig. 37 shows one method which has been developed.

The couple A B C of noble wires is connected in series with a couple C D E made of base metals. Let the temperature of the end B be T, that of the region in which the junctions A C and E are situated be ϕ, and t that of the junction D. This last, the lowest temperature, may be kept constant by any suitable device. The couples must be connected so that the pressures produced act together to give a current through the voltmeter. If we suppose that both couples follow a straight line law of the same kind we have :—

$$E = k\ (T - \phi)$$
$$\text{and } E_1 = k\ (\phi - t)$$
$$\text{therefore } E + E_1 = k\ (T - t).$$

The electric pressure produced thus depends on the difference of temperature between the ends of the junctions.

(To be continued.)

Letters to the Editor.

SOCIETY OF TECHNICAL ENGINEERS.

To the Editors of the "Industrial Engineer."

SIRS,—The North-Western District Council of the above Society would like to draw the attention of your readers to a District Mass Meeting which is to be held at 7-15 p.m. on Friday, April 25th, 1919, at the Milton Hall, 244, Deansgate, Manchester, to which chemical, civil, colliery, electrical, mechanical and mining engineers are invited.—Yours, etc.,

P. HEADON, Hon. Sec.,
North-Western District Council.

2, Mount Street, Manchester,
April 14th, 1919.

Queries and Replies.

WE shall at all times be pleased to help our readers out of their difficulties to the best of our power, and invite them to make use of this column for that purpose.

ANSWER ("ECONOMY").—BOOK ON RUNNING AND TESTING OF STEAM PLANT.—We have been making enquiries *re* the above, but regret to say there is no book which we are able to recommend.

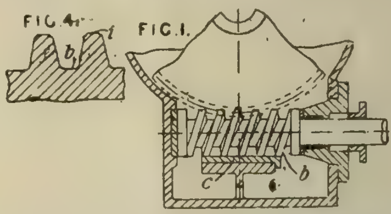
Patent Applications.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

ABSTRACTS OF SPECIFICATIONS.

WORM GEARING.

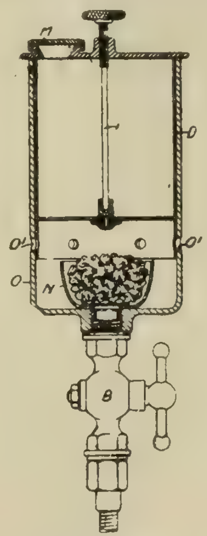
119,352.—J. G. MCKEAN, 17, Ocean View, Whitley Bay, Northumberland.—Dec. 17th, 1917.—The edges of the teeth of a worm *b*, Fig. 1, are supported in a cylindrical bearing *c*, and the edge



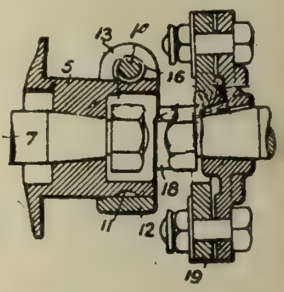
surface of the teeth is reduced in width, as shown at *i*, Fig. 4. The worm is immersed in oil which is circulated through the bearing *c* when the gearing is in motion

INTERNAL-COMBUSTION ENGINES.

119,360.—H. W. JOHNSTON, Dunros, Strathtay, Perthshire.—Dec. 27th, 1917.—A carburettor for starting purposes comprises a container D for light spirit, having a drip valve F, a cup N containing sponge or other absorbent material, a casing O having air inlets O1 regulated by turning the container D, and a cock B leading to the induction pipe. In place of the filling-hole and cap M, the container D may have a perforated top and a screwed cover, and the cup N may be omitted.



Patent 119,360.



Patent 119,371.

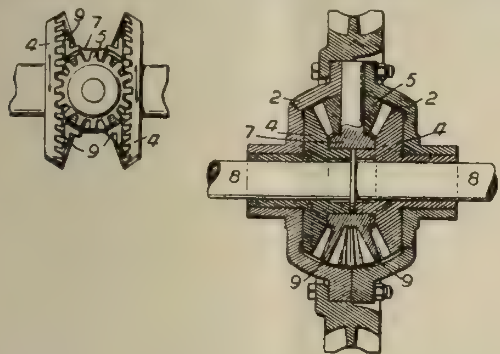
SHAFT COUPLINGS.

119,371.—BRITISH THOMSON-HOUSTON CO., 83, Cannon Street, London.—(General Electric Co.; Schenectady, New York, U.S.A.)—Jan. 8th, 1918.—A shaft coupling is provided with means for adjusting one of its members around the shaft to which it is connected. The device is applicable for adjusting the timing of the ignition of an internal-combustion engine. A clamping-collar 12, having two projections 18 connected to the flexible member 19 of a universal joint, has two lugs 13 drawn together by a bolt 14, the central part of which has a worm thread 16 engaging teeth 11 on a collar 5 mounted on a shaft 7. By turning the bolt, the collar 12 is rotated about the collar 5.

DIFFERENTIAL OR BALANCE GEARING.

119,363.—H. BILGRAM, 751, North Fortieth Street, Philadelphia, U.S.A.—Dec. 31st, 1917.—Excessive independent rotation of the gear-wheels of differential or balance gears for automobiles, etc., is prevented by the use of an oil or grease retaining casing and of guards which fit closely into the angles formed by the intermeshing gears and prevent the ready passage of the lubricant between the guards and the gears. The casing 2 carries planet pinions 5 gearing with bevel pinions 4 on the divided axle 8, the gearing fitting closely within the casing, which is partly filled with oil, grease, or the like. The ring 7 carrying the planet-pinions is provided with guard-like projections 9 fitting closely

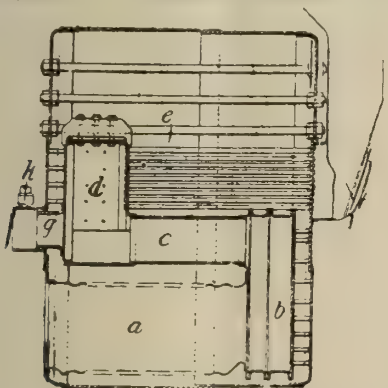
into the angles formed by the intermeshing teeth. The guards may be formed in two parts and be secured to the casing. If relative rotation between the wheels 4 takes place, oil is carried



by the teeth into the angles behind the guards 9, but is unable to pass the pinions 5 owing to the intermeshing of the teeth, and can escape but slowly past the guards 9, so that the rotation is checked and excessive slip of the road-wheels prevented.

STEAM GENERATORS.

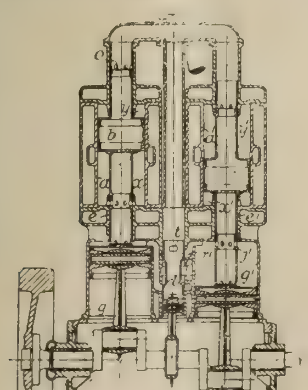
119,377.—W. BIRRELL, 21, Park Street, Liscard, and J. DAVIOSON, 211, Woodchurch Road, Birkenhead, both in Cheshire.—Jan. 22nd, 1918.—Relates to a boiler comprising a number of furnace flues *a*, rear and front wet-back combustion chambers *b*, *d*, and flues or flue tubes *c*, *e* between the chambers and between the front chambers and the uptake *f*. A number of manhole tubes *g* extend



from the front chambers out through the boiler front so as to provide access to the flues for cleaning and repairs. The manhole tubes are preferably of a sufficiently large diameter to allow the flues *c* to be withdrawn through them. Heated air for combustion is admitted to the front chambers through pipes *k* opening into the manhole tubes.

INTERNAL-COMBUSTION ENGINES.

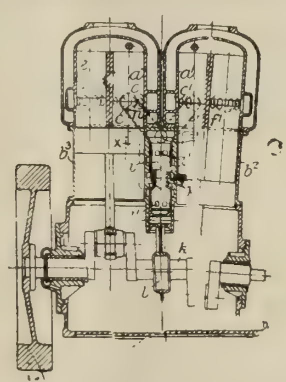
119,401.—J. DAVIDSON, 48, Park Road, Pendleton, Lancashire.—Mar. 19th, 1918.—A double-acting engine with two cylinders *a*, *a1* has co-axial charging pumps *g*, *g1* which each supply an adjacent combustion space and also the upper com-



bustion space in another cylinder. Combustible mixture is supplied to the pump *g* through a passage *r1* which opens into an annular inlet chamber *q* in a piston slide-valve *l*. A portion of the compressed charge is delivered to the combustion chamber *x1* through ports *j1* which register with ports above a partition *e*, and the remainder is transferred to the combustion chamber *y* in the cylinder *a* through ports *o* in the tail-rod of the piston *b* when ports *t* in the valve *l* register with the passage *r1*. Similarly, the combustion chambers *x* and *y1* are charged by a pump *g*. A single-acting engine is described in which a pump piston is carried by a tail-rod on the working piston, the charge being transferred from the pump to the combustion space through the rod. A charge of combustible mixture may be admitted to the pump through ports controlled by the tail-rod, or the admission ports may be valve-controlled. Scavenging air which may enter the cylinder in advance of the combustible mixture, is drawn into the hollow tail-rod during the suction stroke of the pump.

INTERNAL-COMBUSTION ENGINES.

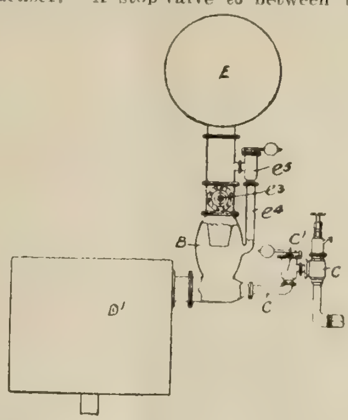
119,414.—J. DAVIDSON, 48, Park Road, Pendleton, Manchester.—April 16th, 1918.—A piston valve *i* controls the distribution of the charges to and from a pair of pump cylinders *b2*, *b3* having pistons which each carry a pair of working pistons acted upon simultaneously by each impulse. The pumps and the cylinders



are cross-connected. Charges are drawn through a port *m* into the interior of the valve and pass through ports *i*, *i1* to passages *x*, *x1* leading to the pumps. The compressed charges are delivered through these passages to an annular chamber *k* connected by branch pipes *n* to piston-controlled inlet ports *c*, *c1* in the cylinders *a*, *a1* respectively. The pistons *e*, *f1* controls the exhaust ports.

UTILISING EXHAUST STEAM.

119,494.—L. J. R. BOUHON, 58, Barlow Moor Road, Chorlton-cum-Hardy, Manchester.—Sept. 25th, 1917.—In apparatus for heating exhaust steam by waste furnace gases and utilising the regenerated steam for heating and driving purposes, steam is withdrawn from a chamber B between the cylinder D1 and the condenser E by an aspirator C working with high-pressure steam, and the steam, after being heated and utilised, does not pass into the condenser. A stop-valve *e3* between the cylinder and

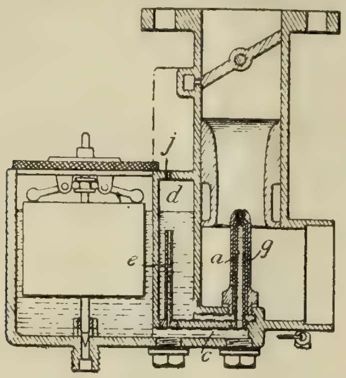


the condenser and a loaded valve *c1* between the chamber and the aspirator are so adjusted that at least one-third of the exhaust passes to the condenser. In the event of a breakdown, the valve *c1* closes, and the exhaust enters the condenser through a branch pipe *e4* containing a loaded valve *e5*. The steam may be heated in pipe coils placed in the boiler flues between a superheater and an economiser, or in nests of straight pipes placed in a chimney or smoke-stack. The pipes of the steam heater are cleaned by jets of steam from perforated steam pipes.

INTERNAL-COMBUSTION ENGINES.

119,508.—J. FAGARD, 2, James Watt Street, Birmingham.—Sept. 29th, 1917.—In carburettors such as are described in Specifications 103,627 and 105,309, comprising a main nozzle fed from the float chamber, and an auxiliary nozzle fed from a chamber or well open to the atmosphere and supplied from the float chamber preferably through an upstanding tube or passage, the aperture through which the well or chamber communicates with the atmosphere is of restricted dimensions and may be controlled. This ensures that, at high speeds, a vacuum will be produced in the well or chamber sufficient to produce a flow of fuel thereinto and bring the auxiliary nozzle, which is usually employed

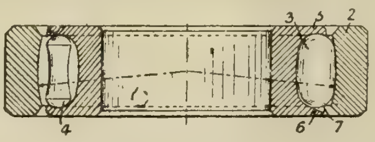
for accelerating, into action again to maintain the mixture strength. The auxiliary nozzle g may surround the main nozzle a, or may enter the mixing chamber at right-angles thereto. The aperture j may be controlled either manually or by a barometric device. The vertical tube is shown at e and the well at d. To ensure that the chamber d becomes emptied,



and the nozzle g goes out of action at medium speeds, a restriction may be placed in the passage c between the float chamber and the well or, for the same purpose, the top of the tube e may be above the normal fuel level. According to the Provisional Specification, the well or chamber may communicate with the induction pipe, and the main nozzle may be supplied therefrom.

BEARINGS.

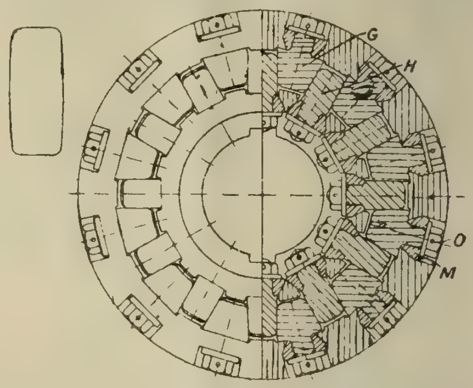
119,432.—T. R. BLOMBERG, 56, Block Volcanus, Hufvudsta, Sweden. July 3rd, 1918.—In a roller bearing having an outer



spherical race 2 and recessed flanges 5, 6 on one of the race rings to retain the rounded ends of main and spacing rollers 3, 4, a recess 7 is formed in one of the flanges to enable the rollers to be inserted.

SHAFT COUPLINGS.

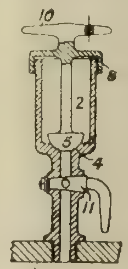
119,416.—G. E. BENCH, Quebec Chambers, Quebec Street, Leeds.—April 26th, 1918.—A flexible shaft coupling or universal joint for ships' propeller shafts, etc., comprises a number of blocks G, H arranged on the two parts to be connected, each block being free to turn on its radial axis. The blocks fit together as shown, and to enable them to rock, the sides are bevelled as shown.



Each block has a square shank fitting a hole in a conical plug M secured by a nut O. Helical oil passages are formed in the surfaces of the cones M to provide for lubrication. The coupling may revolve in an oil trough.

INTERNAL-COMBUSTION ENGINES.

119,616.—A. S. WELPLY, Rosendale, Corbally, Limerick.—Mar. 15th, 1918.—A device for priming and relieving compression comprises a priming cup 2 having a screw cover 8 formed in one with the



stem of a valve 5, which closes on a seat 4 when the cover is screwed on. A handle 10 is formed on the cap and a plug-cock 11 may be provided.

INDEX TO ADVERTISERS.

[When enquiring of Advertisers will readers kindly make a "special point" of mentioning THE INDUSTRIAL ENGINEER.*]*

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All communications intended for insertion in the INDUSTRIAL ENGINEER, *or relating to Editorial matters, should be sent addressed to "The Editor," at our Office,* 121, *DEANSGATE, MANCHESTER, and must be accompanied by the name and address of the writer. Anonymous letters will not be noticed. We cannot undertake to return manuscripts or drawings, and correspondents are warned to keep copies.*

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CONTENTS.

EDITORIAL.

TECHNICAL EXPRESSIONS.

WHENEVER it is desired to alter, amend, sell, or influence, it is necessary to explain to those having the power of choice or veto. This applies equally to solicitation as to more ordinary connections.

The Value of Simple Terms.

In one sense it may be a waste of time; it is clearly impossible to turn the ignorant into the expert by momentary and desultory question and answer; yet for all that, any proposal having sense must be susceptible to rational exposition in more or less simple terms, and its advocate must be in a position to meet objection and answer even futile query.

Divested of technicality, quite abstruse subjects in the hands of those having the gift of expression can be made both interesting and fascinating. There is one type of discussion between expert equals which assumes much for granted, and another when information is sought by those less competent. The subject is not without importance to those seeking to become expert, no less than to the man in the street unable to afford the time or without permanent interest. Thus explanation depends in no small measure upon the expositor's human diagnosis, as well as upon his knowledge of his subject.

The Necessity of Arousing Interest.

To arouse interest is cardinal to both tuition and trade; without such, stimulation, novelty, and improvement are apt to receive scant commercial regard, and the progress of the student is to a great extent dependent upon the interest with which the tutor can invest his subject.

The technician is apt to prove a rather poor expositor unless he is dealing with someone who has himself considerable technical understanding; the points of technical interest may be acute, but apart from others more directly commercial. Frequently the technical man has small regard for intrinsic value; it is not his forte, and his training, while embracing efficiency and economy, lacks the sense of competitive value.

Education depends initially upon arousing interest and making the imagination of the student; without the enthusiasm thereby invoked, the dry bones of knowledge remain unclothed with vitality. It is insufficient to impart knowledge; in must be given in intelligible terms, in such wise that its symbols are familiar and evoke quick response in the mind of the student. While this is true, it is, of course, unwise to consider utility merely, for most knowledge is indirect in its application; very rarely can it be applied without transposition. The successful propagandist is aware of this psychological necessity for reduction to simple terms, so also is the expert advertiser.

It is impossible to resist the conclusion that arresting presentation of thought and idea is dependent upon much else than a simple recital of facts, or catalogue of advantages, though both have their place in the scheme of things.

Convincing Expression.

Expression which leaves conviction in the mind of the interlocutor is the sequel of hard thinking; it is necessary to clarify complexity before presentation; he who senses a new idea finds it most often elude definition when the first attempt is made to give it fixity of tenure. When in being even, the conception has to challenge criticism which finds the weak places and often involves re-expression tanta-

mount to new discovery, it is often the critic who, probing mercilessly, discovers new advantages to scheme or devise. There is a shrewd suspicion that when it is found impossible to phrase some simple analogy, the knowledge itself is obscure; the idea opaque, it lacks the summation which places its utility beyond question. It is ingenuity of expression which is taxed in the presentation, where the idea is sound and clear exposition is lacking, it involves another process of mind quite apart from creation.

Provocation and Faith.

It is the enthusiast who is provocative, and it is the extremist who has faith, who both tend symbolically to shift mountains, whether these be prejudice, vested interest, or current practice. Their distinguishing mark is facility of expression, not necessarily the creation of novelty; they expound, criticise, and convince. To the born salesman such gifts are usual, but latent capacity in this direction can be raised by cultivation. It is not very wide of the truth to say that most technicians are deficient in this sense; they do not suffer the ignorant gladly, are too apt to find elementary explanation tedious, consider the first rebuff final. It is largely a want of expression which causes lack of success in this particular; they know, but cannot teach.

Demonstration an Art.

The art of demonstration is one of the fine arts, and like all the others, demands both natural gift and training. There are many ways in which expression can be cultivated apart altogether from salesmanship, and full advantage should be taken of whatever means are open.

It is a real pleasure to be placed in the hands of the expert demonstrator who really knows his business and who is specially competent; the flexibility with which he will adjust to the mentality of the engineer and the sequence of his exposition are alike interesting as a piece of art. In this wise it is not always that the maker of a device can best testify to its merits; they have often to be translated out of ambiguity to clarity and placed in proper order to convert the recalcitrant and persuade the uninterested. It needs another type of mind to that needed for production, manufacture, or design. Moreover, although demonstration involves knowledge, this need not be of the most abstruse order. Curiously enough, the usual objections are mostly elementary and below the plane to which the expert can stoop, or of an order which has little to do with technicality at all. There are times and occasions when the case is different, when discussion ranges upon basic principles and abstruse points; in such case, the peculiar need for expression is lessened by the opposition being expert and able themselves to diagnose; such instances are rare.

Clearness Above All.

Expression—the art of infinite variety—is useful in all connections; it is a pity that so few technicians cultivate it, because they are thereby the losers. There is too much tendency to deprecate what is adversely termed "mere clerical ability," which is very largely the art of clear expression put to use. The practical man avoids its cultivation in very many instances to his own eventual discomfiture, for it is an essential to the transaction of business. The ability to write a decent letter, compile a digest or well-phrased report, simplify or co-ordinate results, meet complaint or objection tactfully and easily, or employ a good vocabulary, are by no means common in technical connections. It is not that mentality to acquire them is wanting, it is disinclination to face their possible need which leads to the condition deplored.

THE INDUSTRIAL SITUATION.

From an Employee's Standpoint.

Though the threatened strike of the Triple Alliance is for the moment called off, matters are far from satisfactory in the world of industry, and the present appearance of quiet may be only the calm that precedes the storm.

The report of the Industrial Conference, advocating a closer union between employer and employed, will lead to no result whatever unless the pressing and serious danger of rapidly-increasing unemployment be immediately and vigorously dealt with.

Unemployment a Standing Menace.

The million persons now in receipt of unemployment benefit are a standing menace to anything like industrial peace. Moreover, it is a growing danger, as we are told that these numbers are being added to at the rate of 14,000 weekly. People desiring work and unable to obtain it are the very kind who rapidly assimilate revolutionary ideas, and very often endorse methods of procedure which under different circumstances they would vigorously oppose.

This is the real drawback to industrial concord, and the only way to avert catastrophe is to provide work for those who require it, in preference to the payment of a slight premium on idleness. The present iniquitous and costly system of paying out-of-work donation must be done away with, and useful and profitable employment must be found at fair rates of pay.

Abundance of Work.

There is abundance of work waiting to be done, all of which would prove ultimately of immense profit to the entire community. For instance, the provision of light railways, particularly in the agricultural districts, facilitating the transport of foodstuffs from the producer to the consumer.

The repair and development of our inland waterways and canals, with the application of electricity as a tractive force wherever possible, is another instance presenting immense possibilities.

Re-afforestation is another matter of extreme urgency. During the war, owing to the difficulty of obtaining foreign timber, our native timbers were requisitioned in unprecedented quantity, and with the result that our stock of native timber has been seriously depleted, and such depletion cannot be made good a minute too soon.

It is pleasing to note that an early start is to be made on the work of reclaiming some of our foreshores, and it is announced that experts are already engaged on some sections of Morecambe Bay, with a view to early operations. This is good news, and will be welcomed as a start in the right direction.

Economically, it is a sound policy, for it is far better to pay a man wages for doing useful work than

it is to grant him a pittance which will only tend eventually to make him an inefficient worker. The one and only cure for unemployment is the provision of work.

Bolshevism and Trade Unions.

Some sections of the Press are fearfully agitated about the growth of what they are pleased to call "Bolshevism" amongst the workers of the country. As one who knows the British workman far better than most, let me say, here and now, that most of that which is written about Bolshevist agitators and their influence in trades union circles is mere "blether."

The British workman is out for better conditions of both life and labour, but as a class he is not out for revolution. He is sufficiently educated to know that the facilities for producing wealth are greater to-day than has ever been the case at any time in the history of this old planet of ours, and what he wants to know is, "where he comes in." He sees manual labour displaced by highly-developed mechanism in every direction, and he has come to the conclusion that some part of the benefit accruing therefrom ought to be his in the shape of better pay and shorter working hours; but let me say, he is very sensible of the fact that there are others to be taken into consideration and that there must be a limit to his demands. The spirit of fair play is not dead yet, and I know that as a class the workers are reasonable. This is the experience, at any rate, of one who is in constant touch with thousands of them.

Organisation and Reciprocity.

Two factors are necessary to ensure industrial peace, namely, organisation and reciprocity. To secure the first factor we require men of undoubted organising ability, men who know their job and have acquired their experience in the right school. The methods of the old-time bully foreman are obsolete; leaders are the men required in industrial life to-day. Men whose practical knowledge points the way to the most efficient method of doing a job, resulting in the saving of labour and the production of the high-class article.

No industry should be so productive of capable organisers as that of engineering. The education of the engineer is based on the co-ordination of sections to produce a given result, and such training fits men to deal effectively with the great problem of industrial organisation as a whole, and it is high time they began to assert themselves as a class and aspire to occupy their rightful position in the State.

A man may be an eminently successful lawyer, a profound statesman, or an eloquent politician, but these are not attributes to ensure success, where the first essential is practicability.

We have had quite sufficient bungling and mismanagement during the war period, and we have had to pay dearly for it as a community. We cannot afford to repeat the experiment; it is too costly. The men required for the job of reorganising industry can only be found in the ranks of those who have received their training under conditions which are bound to bring out a man's capability, where he must work with and understand the foibles of his fellows, and, sensible of his own limitations, be prepared to profit by any and every hint and circumstance that is likely to enhance his knowledge and widen his outlook. Such men can only be found where large numbers are employed and where multifarious operations are conducted. A lawyer's office is the last place where such an experience and training is possible.

Much has been talked and written about the establishment of a better understanding between employers and employed. Genuine reciprocity between the two sections can only be established by genuine respect of the rights of both. Those in authority must be prepared to consider all the just claims of those subordinate to them, and such consideration on a broad basis should engender the goodwill and respect of the latter towards those having the direction and supervision of industrial affairs. This can be brought about by bringing together the most broad-minded of the two sections, and a result of their joint efforts, either in a single establishment or in the whole of an industry, would be productive of better feeling and the elimination of friction in hundreds of instances.

It is upon these lines we shall achieve a lasting and glorious industrial peace, and successfully emerge from the present transitional state to a better and brighter future.

Justice Sankey's Report.

Incidentally, the Report of Justice Sankey has made a profound impression for good. It is looked upon as a masterpiece of unbiased judgment, and has created a feeling among working folks, that there are still to be found those who will justly and honestly weigh and consider the claims of the workers, even though they themselves are of the higher professional class. Such an impression created at this juncture is of priceless value to the community at large, and its effects will be more far-reaching and beneficial than all the veiled threats of force and compulsion.

One result, which looks extremely likely, is the anticipated acceptance of the said Report by the Miners' Federation of Great Britain, and I believe that the ultimate result will be a general reorganisation of the Coal Industry.

The settlement of the piece-work question in the engineering trade tends toward harmony in that quarter, and if something effective can be promulgated with regard to the hours and wages of cotton operatives, then we are in a fair way toward industrial peace and concord.

The period of transition from war industry to peace conditions is bound to be a critical one, and I would advise the provision of such work of public utility, as is indicated in the commencement of this article, so that we as a community may pass through the crisis, with as little suffering and commotion as possible. It will require an exercise of patience and goodwill, on the part of both employers and employed, but with these and the dogged persistency which is so conspicuous in the national character, we shall come through triumphant, and by a judicious use of our talents and opportunities set about making that new and glorious Britain, which is our heritage and our right.

A remedy recently advocated for the prevention of the growth of cast iron, due to prolonged exposure to high temperatures, is the elimination of free graphite from the surface of the metal. Successful results are said to have been obtained by annealing the parts for several days in iron rust at a temperature of from 1,650 to 1,830 deg. Fah.

GOVERNORS AND GOVERNING MECHANISM.

By A. Houlson.

(Continued from page 252.)

Plotting Motion of Eccentric Rod, Etc.

To plot the motion of the various parts proceed thus (see Fig. 48): —

(1) Take any number of points on the expansion eccentric travel circle; for clearness we have taken three, viz.: A, B, and C.

With the length of the eccentric rod as radius, and point B as centre, strike a small arc cutting the centre line of the engine in point B. With points A and C respectively as centres, and radius = length of eccentric rod, strike two other small arcs above and below the centre line.

(2) From the point K, the centre of the fulcrum pin for the slot link, with a radius = K B_1 draw an arc A_1 C_1. This will cut the eccentric rod arcs in A_1 and C_1. Join A A_1, B B_1 and C C_1. This gives the position of the eccentric rod for the two extreme positions and the "mid" position of the gear.

(3) From the point K as centre, and with radius K B_2 draw the arc A_2 C_2.

Note.—B_2 is the intersection of the slot link centre line with the centre line of the engine.

(4) Make a tracing of the slot link marking point B_2 on the centre line of link. Then, placing the link on the drawing, move the point B_1 to A_1; then the point B_2 on the link will have moved from B_2 to A_2. Prick through at A_2. Proceed in a similar manner to find the point C_2.

(5) Mark off the centre line of the slot link in the three positions 1, 2, and 3, by pricking through the tracing paper.

(6) From the centre P the centre of the fulcrum pin for the suspension link in the governor levers, and with radius = length of suspension link, draw an arc A_3 B_3 C_3. Note that the point B_3 should lie on the centre line of the engine. Draw two other arcs U, V, W, and X, Y, Z, with the same radius for the top and bottom positions of governor levers.

(7) Make a tracing of the radius rod, marking on the centres B_2, B_3, and B_4. Then, placing the tracing paper on the drawing, keeping the point B_4 on the centre line of the valve spindle, the point B_3 on the arc A_3, B_3, C_3, and the point B_2 on the centre line of the slot link, the travel of the point B_4, in other words, the travel of expansion valve may be found.

Table II. gives dimensions of several sizes of Hartnell type gears. The pressure per square inch on the rubbing surface of the valve should not exceed 230 lbs. per square inch.

TABLE II.

Travels.			Main Valve.			Expansion Valve.		Lifts.		Controlling Force of Governor measured at surface of Expansion Valve.	
Main Valve.	Expansion Valve.		Depth of Port.	Width of Port.	Steam Lap.	Negative Lap.	Negative Following Lap.	Governor.	Die in Slot Link.		
	Maximum.	Minimum.								Total	Per sq. in.
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	lbs.	lbs.
2	$2\frac{3}{8}$	$\frac{3}{4}$	$4\frac{1}{2}$	$\frac{9}{16}$	$\frac{1}{2}$	$\frac{5}{16}$	$\frac{1}{8}$	$2\frac{5}{8}$	$6\frac{5}{8}$	16·1	·398
$2\frac{1}{4}$	$2\frac{3}{4}$	$\frac{7}{8}$	$5\frac{1}{2}$	$\frac{5}{8}$	$\frac{9}{16}$	$\frac{11}{32}$	$\frac{3}{32}$	$2\frac{5}{8}$	$6\frac{5}{8}$	14	·254
$2\frac{1}{2}$	$3\frac{1}{32}$	$\frac{31}{32}$	6	$\frac{11}{16}$	$\frac{5}{8}$	$\frac{3}{8}$	$\frac{1}{8}$	3	$6\frac{3}{4}$	20·9	·314
$2\frac{3}{4}$	$3\frac{7}{16}$	$1\frac{1}{16}$	$6\frac{1}{2}$	$\frac{3}{4}$	$\frac{11}{16}$	$\frac{13}{32}$	$\frac{9}{32}$	3	$7\frac{11}{16}$	18·2	·23
3	$3\frac{5}{8}$	$1\frac{1}{8}$	$7\frac{1}{2}$	$\frac{13}{16}$	$\frac{3}{4}$	$\frac{15}{32}$	$\frac{1}{4}$	$3\frac{3}{8}$	$8\frac{11}{16}$	25·7	·244
$3\frac{1}{4}$	4	$1\frac{1}{4}$	8	$\frac{13}{16}$	$\frac{15}{16}$	$\frac{1}{2}$	$\frac{5}{16}$	$3\frac{3}{8}$	$9\frac{1}{4}$	23·4	.212

The valve spindle diameters range from $\frac{3}{4}$ in. for the small size to $1\frac{1}{4}$ in. for the large, and the guides vary from $1\frac{1}{4}$ in. diameter to $2\frac{1}{2}$ in. diameter. The length of the guide bracket may be two and a half times the diameter.

(To be continued.)

BOILER FUELS AND EXTERNAL CORROSION.

By Edward Ingham, A.M.I.Mech.E.

External corrosion of the plates of steam boilers is generally admitted to be one of the principal causes of deterioration, and it is probably the fact that more explosions have occurred from this defect than from any other.

The trouble in question is mostly the result of allowing the boiler plates to become damp externally, and all that is usually necessary to overcome the difficulty is to maintain the plates in a dry condition. In the case of Lancashire boilers, for example, a common cause of deterioration is wasting about the lower parts of the front end plate, due to the presence of damp ashes on the floor plates in close proximity to the end plate. Again, water tube boilers frequently suffer severely from external corrosion of the water tubes due to leakage from the various joints.

Other examples might be given in support of the statement that all classes of boilers are liable to suffer seriously from external corrosion caused by damp.

Now, whilst damp is undoubtedly the main cause

of external corrosion, it is not the only cause. The fact is not so generally recognised as it should be, that the nature of the fuel used in the boiler furnaces is often responsible for severe external wasting of the plates. Many coals, for example, contain a good deal of sulphur, and this, in combination with the moisture contained in the furnace gases, forms corrosive acids which have a powerful action in corroding the plates.

The wasting which arises in this way is often of a very smooth character and, therefore, difficult to detect. The flue tubes and the external shells of Lancashire and Cornish boilers are frequently found affected by this type of wasting. This is particularly the case with boilers fired by coal from the Warwickshire district, especially the fine quality known as "smudge." Such smudge often contains a high percentage of sulphur, which, in combination with moisture, forms sulphurous and sulphuric acids. Unfortunately, where this smudge is used, it is a common practice with the fireman to throw water on the fuel with the object of forming it into a damp mass which can be the more easily handled. This damping naturally increases the tendency to wasting, and is a very objectionable practice.

Locomotive-type boilers are particularly liable to suffer from wasting due to the action of the fuel. For example, some fuels give off hard particles and grits, which, owing to the intense draught, are blown hard against the heating surfaces, so that they cause severe abrasion of the plates. If the firebox is constructed of copper, this abrasive action is liable to produce rapid wasting

In some cases, as, for example, at timber works, wood fuel is largely employed for firing the boilers, and such fuel frequently causes severe wasting. With Lancashire and Cornish boilers, the use of wood fuel sometimes leads to severe wasting about the level of the fire bars.

Occasionally, boilers are fired by the exhaust gases from gas engines. These gases often contain a large proportion of sulphuric acid, which is highly corrosive, and which causes rapid wasting.

Chemical analysis of the deposit on the external plates of boilers fired by the exhaust gases from gas engines has revealed the presence of as much as five per cent free acid in certain instances.

From what has been said, it will be seen that the fuel used in a steam boiler may play an important part in causing external corrosion. Hence, where severe wasting is met with due to this cause, it may not be inadvisable to consider the question of substituting the fuel by another one.

ENGINEERING LAY-OUT ARRANGEMENTS AND TENDER DRAWINGS.

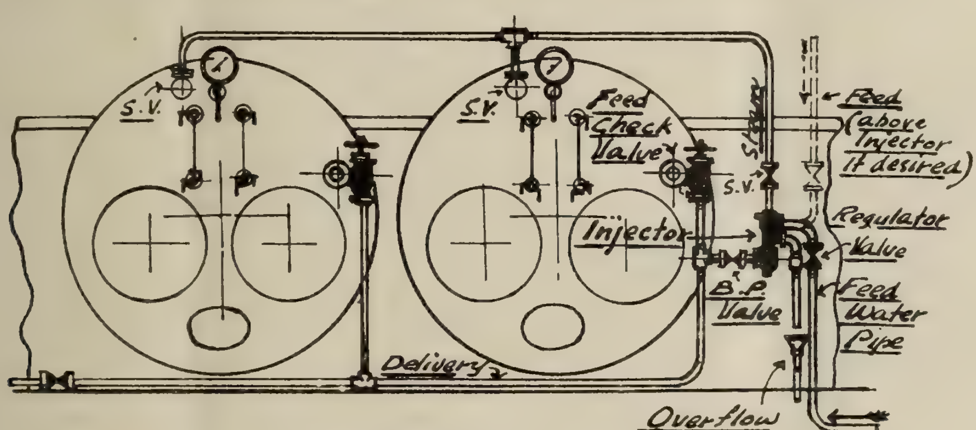
By Douglas Wilson, A.M.I.Mech.E.

(Continued from page 249.)

The Injector Connections.

In most power plants the injector is generally used as a stand-by to the pump; the efficiency of the former, from a mechanical point, is low, but from the thermal standpoint it is more or less perfect. Injectors are, however, cheaper than pumps, ready to work at a minute's notice, and can supply hot feed, but use more steam compared with the pump.

The injector should be fixed as close to the boiler as possible, and avoid tees and sharp bends. The steam supply should be taken off an independent pipe from the boiler, and not from the main, as it is necessary to supply the injector with dry steam. The ideal arrangement of injector is to have it fixed in conjunction with a feed pump, the one serving as a stand-by to the other. This avoids stoppage of a boiler should either pump or injector become disabled.



Engineering Lay-out.—Fig. 62.

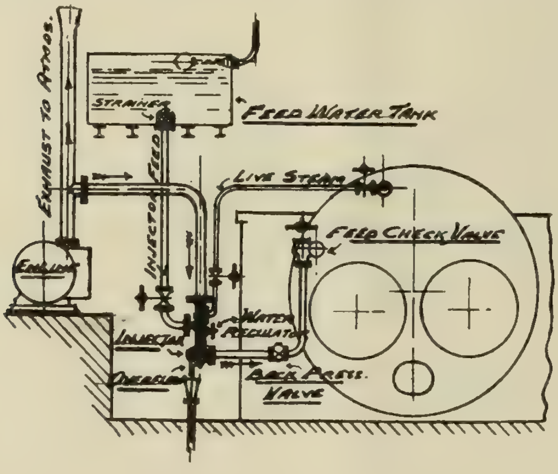
An arrangement of this method will be shown later. The temperature of the feed water should not exceed 120 deg. Fah. for live-steam injectors; overflowing takes place if this temperature is much exceeded. The water supply to the live steam injector may be either above or below it; the height of lift may be between 10 and 20 feet according to pressure. The suction piping should always have a rose at the end of it, and a foot valve for high lifts, and all joints in the pipe should be air-tight. The overflow should be visible and not be connected directly to the drain. Fig. 62 shows the general layout of a live steam injector feeding two boilers. This represents general good practice. A back-pressure or check-valve must be fixed on the delivery pipe between the injector and boiler, and also a stop-valve on the steam-supply pipe, and a regulating cock on the feed-water supply pipe. As

will be seen, the steam supply is taken direct from the boilers, and the overflow pipe in the injector discharges into a funnel, thence to the drain.

Self-acting or automatic live-steam injectors are mostly used now, as they start to work instantly on opening the steam valve, and require no regulation of steam and water after once being set for usual working pressure. Ordinary non-automatic injectors cease to work should the water supply be momentarily shut off, and will not restart until the steam and water is shut off and the instrument re-adjusted by hand. Hence the reader will see the advantage of installing in the boiler equipment a restarting or automatic injector. When the draughtsman orders the injector it is necessary to state on his order, the maximum and minimum steam pressure, (2) the height the injector is to lift, (3) temperature of feed water and the type and number of boilers to be fed.

The Exhaust Injector Connections.

Exhaust steam injectors can be profitably used in lieu of the live-steam type where non-condensing engines are used, and steam hammers, etc. A saving of 10 per cent in the fuel is commonly obtained.



ENGINEERING LAY-OUT.—FIG. 63.

They can be worked with live steam as an ordinary injector when the engines are standing, this making them very popular. The exhaust steam injector delivers the feed at a much higher temperature than live steam injectors, thus serving the purpose also of a feed-water heater. For boiler pressures, however, exceeding 120 lbs. per square inch., it is necessary to provide a small supplementary jet of live steam in the injector, when it can then feed against pressures up to 250 lbs. per square inch. Like the live steam injectors, these are made perfectly automatic and re-starting.

For determining the size of injector required, it is only necessary to supply the makers with the number of cubic of feet of exhaust steam emitted from the engine per minute, and whether the supply of exhaust steam is regular throughout the day, and they will quote for a suitable size. The working boiler pressure must, of course, be stated.

Fig. 63 shows, diagrammatically, the method of fixing this type of injector. It will be noticed that the injector is below the feed-water supply. This is necessary for all types of exhaust steam injectors. The injector must be fixed vertically, and the exhaust connection should be taken from the main exhaust pipe as far as possible from the open end, the branch pipe being connected to the side of the pipe, if vertical, and to the top if horizontal. A back-pressure valve should be fixed a foot or two from the injector on the delivery pipe if this is long, and the live steam must be taken directly off the boiler and not off a steam main. As the exhaust injector is automatic, it may be used on intermittently-acting engines, such as winding engines, the injector starting and stopping with the engine.

There are several good makes of these injectors on the market, none differing much in general design and detail; most injector makers can supply them. Messrs. Davies and Metcalfe, Romiley; Messrs. Holden and Brooke, West Gorton; and Messrs. Royles Ltd., Irlam, are very reliable, amongst others which the writer is not so well acquainted with.

(*To be continued.*)

SOME INTERESTING POINTS IN RELATION TO OIL PROSPECTING.

(*Continued from page 267.*)

Avoid Geologists.

"Another class to be avoided are the geologists, who set all their faith on perceptible anticlines; take no stock in them; when there are none of the materials in sight on such anticlines you are in search of. California was full of such fakers when the oil was first struck in the Kern River fields early in 1900 or 1901. The geologist got the anticline so well in the brain of the capitalists of 'Frisco and Los Angeles that they rushed into Kern hills and paid from one to five thousand dollars per acre to men who held claims on Government lands; companies began to be formed by dozens each day in each city; stock was sold to investors; both rich and poor were invited to get in on the ground floor, which they did, and the majority of them certainly did; they even got in the hole and are not out of the effects yet, for it was the financial ruin of thousands.

"In the year 1897 Mare Island was damaged to the extent of one million dollars (according to press reports) by an earthquake. In 1898 I had occasion to go to the New England States on business; I put in my time in prospecting for oil, first in the City, then in Oakland, Alameda, Berkeley and Port Costa; I found by means of my fork stick, as I expected, these places to be full of oil. In the year of the rush to Kern, as already stated the Press published an oil map of the Kern River fields, etc., giving the supposed location of the oil-bearing lands therein. I wrote a letter to them, how foolish it was to go for oil there, when there was so much oil beneath their city and on the other side of the bay; and a market at their door and transportation facilities by land and water to all points of the compass, while the oil at that time they were using was costing them over 1.50 dollars per barrel, but in Kern the producer was selling and was glad to sell his oil at seven cents per barrel at the well at that time. I warned them in that letter, that if they did not take the oil out they would wake up some morning to find their city in destruction and a large loss of life. They returned my letter to me with the usual compliments and

thanks, but had not room for it at that time. I sent it to the *San Francisco Examiner*, and they also returned it, but I was determined to make known, as I felt it my duty to do so, in order to prevent if possible such a sad calamity, which I, by the use of the rod and the chemical knowledge of the oil and gas contained in the earth, and the effects of these oils and gases to life and property, that I sent it to the San Francisco *Mining Review* to Mr. Fitzsimmons, but he, through some cause or other, did not publish it and did not return it either. If Mr. Fitzsimmons is still alive I think he will remember that letter, for he was in the earthquake which took place in 1906. That brings me back to what the Duke of Westmorland is quoted as saying in the House of Lords in the paper item which you enclosed, which stated that he would demand ninepence per gallon for every gallon of crude petroleum oil taken out of his domain.

"Now, we are buying kerosene lamp oil for lighting and heating purposes for 12 1-2 cents per gallon retail in five-gallon lots delivered to the house, or only sixpence in your money, while he demands 18 cents per gallon for the crude. I have just had my grocery man deliver five gallons of the same while I am writing this to you: this oil is made from the California crude asphaltum base oil by the Standard Oil Company. The California asphaltum base oil is the best lubricating oil of any crude I have yet tested, as it stands a much lower temperature than does that of the best paraffin base oil and remains fluid, and it has a much higher fire test, but is less in viscidity; I use five gallons a week of the kerosene lamp oil.

Cost of Oil in America.

"Twenty-five years ago the Standard delivered kerosene oil in this city in bulk and sold it at 12 1-2 cents per gallon to the pedlar and would not allow him to charge the consumer over two cents, or one penny in your money, per gallon profit; at that time they sent what oil was used here in Southern California 3,400 miles from their Philadelphia refinery; and besides that they had to pay an inter-State charge of eight cents per gallon on kerosene lamp oil, which only left them 4 1.2 cents for the oil and refining it, inclusive. All the profit they got at that time was one-half cent per gallon our money, or one farthing in your money, while the Honourable Lord wants a net profit of ninepence, or 36 farthings per gallon; and he has not to pay one farthing of cost, either for the crude or the cost of refining it, or of transporting it. It would be well for the owners of any oil-bearing lands that may be found in the United Kingdom (and I think it would be no trick for me to find it, for I feel certain you have plenty of it) that they should be more considerate to the others who have to do the work and find the money to search for it, viz., those who labour and the capitalists; and last, those who have to use it in particular. It is true, as Lord Cowdray says, it costs money to search and develop oil lands and bring in oil wells; he has had the experience on different continents, and I can say from facts, many are the dry holes he and his associates got here in California and other countries; and many are the wells I can count and name here in nearby fields brought in that have sent up a roaring stream of oil over the top of an 80 ft. high derrick seven inches in diameter, and drowning both the drillers and their 'toolies,' with the dirty black stuff; both watches or shifts would be called out and they would work like Trojans to get the well under control, all of them smelling, even the 'toolies' would feel as proud as a dog with two tails to see that their labour had been productive; and often and many are the dry holes I have predicted and seen made by the same crews, and had to abandon the holes and withdraw all the casing they could. These same crews looked as sad as though they had been burying some friend; they had; they had buried their labour for ever in those dry holes.

(*To be continued.*)

THE WAGE PROBLEM IN INDUSTRY.*

By W. L. Hichens

(Chairman of Cammell Laird and Co. Ltd.).

The greatest problem that has to be faced in this country to-day, indeed that calls for settlement throughout the whole civilised world, is the relation between labour and capital. An antithesis which is in many respects false has been set up between these two great factors in production, and the community of interest which is the real foundation of both has been overlaid by less essential differences. For without labour capital is a drug in the market, and without capital labour is as a watch without its mainspring. Modern industry is impossible without a plentiful supply of capital, and the greater the industrial developments in any country become the more urgent are the demands for increased capital. If the world-cry for *novæ tabulæ* were realised today, if by a revolutionary stroke of the pen all capital were confiscated and all capitalists were blotted out, the next act of the destroyers would necessarily be to breed up a new race of capitalists, to offer such inducements as might be necessary to persuade people to save a portion of their income and devote it to schemes of future development instead of spending it on the desires of the moment. For there is no other source from which capital can be derived except savings, and no one will save unless he has a sufficient motive. True, the sole motive for saving need not be the *auri sacra fames* which economists are wont to extol; but it is equally true that unless some financial compensation is offered for the sacrifice of immediate enjoyment which is involved, the majority of people will not save—the necessary capital will not be forthcoming.

Hence, antagonism between capital and labour is not of primary, but of secondary importance, the fundamental fact being that each is essential to the other. It is the community of interest between capital and labour which must always be the basis of industry, and the success of any schemes which are based on the suppression of the one or the oppression of the other will involve the whole industrial edifice in ruin, because the foundations will have been destroyed.

But human nature is such that we tend to pursue the shadow instead of the substance. We are so busy quarrelling as to how we shall cook our hare that we fail to catch it; we are so pre-occupied with the distribution of wealth as between capital and labour

* Paper read before the Royal Society of Arts.

that we tend to forget the laws governing its production; we divide up our cake before it is made, and are in danger of waking up one day to the unpleasant reality that we have elaborately arranged for the distribution of something which does not exist.

Increase in Wages.

I have begun my paper purposely with what may appear to many to be a digression, because in considering the question of the division of the proceeds of industry as between labour and capital, which is the essence of the wage problem in industry, it is necessary always to bear in mind that this problem cannot be considered in isolation from that of production—that the one inevitably conditions the other, and must be determined in relation to it. Most people will, I think, agree that we are inclined to ignore this relationship in practice. For, on the one hand, if an increase in wages is opposed by employers they are apt to ignore its effect upon the productive capacity of the workers. They do not fairly balance the effects produced by discontent, by a lowered vitality, by a loss in efficiency, against the more obvious economies of a low wage; they do not study with the care that it deserves the problem of industrial fatigue; indeed, they are sometimes disinclined even to allow the problem to be studied for them because they regard it as a new-fangled idea; they do not always devote the same care or thought to the efficiency of the human machine as to the inanimate machinery of their workshops; they do not always realise that we are all largely conditioned by our environment, and that it is unreasonable to expect the high ideals, the generous instincts, the well-balanced mind, which are prime factors in developing the best workmanship, to flourish in squalid surroundings amidst the deadly monotony of grinding poverty.

The workers, on the other hand, make their demand for increased wages with little or no regard to its probable effect in restricting production. They think vaguely that all increases can come out of profits, and do not pause to consider what will happen if the profits are insufficient for the purpose, as they nearly always are, and if the increase must be met, as it nearly always is in the long run, by a rise in prices. A general increase in wages followed by a general increase in prices leaves them no better off than they were before, but rather worse off; for not only will the cost of living increase, but, what is even more serious for them, consumption will be reduced and unemployment will supervene. To be really effective, an increase in wages must be conditioned in one or all of three ways:—

1. It must be accompanied by a reduction in profits, so that a part of the wealth previously going into the pockets of the capitalist may accrue to the worker. But this is only permanently possible if the rate of interest left to the capitalist is sufficient to attract fresh capital—*i.e.*, to encourage saving—for no industry can exist without a continuous inflow of fresh capital.

2. The increase must be particular, not general: it must not extend to all trades and classes of workers. An increase in wages really means an increase in relation to somebody else; otherwise it loses its value, for if the wages and salaries and profits of everybody were all increased proportionately at the same moment nobody would be one whit better off than they were before. Money is, of course, merely a token, and to multiply the number of tokens that each individual possesses adds nothing to the realities for which they stand. To increase the points for which you play at bridge involves no increase in your capacity to pay your losses—rather the reverse.

3. Increased wages must be accompanied by increased production. This is by far the most important factor in ensuring a real as opposed to a nominal increase in wages. In other words, increased wages must be conditioned by increased efficiency. It may be that the added productivity is brought about by improved mechanical devices—and there is an ever expanding horizon before us as we advance along the roads of science—or it may be that increased well-being will bring greater efficiency in its train. In this case there will be some reality behind the token increases, and the result will be permanent gain to the whole community instead of an artificial inflation of the currency.

(To be continued.)

ON STANDARDISATION AND STOCK.

By W. Roland Needham.

It is accepted in a general way that the future success or failure of our industries largely hinges upon the pivotal question of production. Within the last few weeks Lord Leverhulme and others have passed many pregnant observations upon this head, and the Premier himself has not been silent. Nor is what has been said wholly theoretical or visionary. Conservative and rut-bound ourselves, we have at least the facts and results from other nations' experiences and experiments to guide us. Slow, if sure, but with the name for extremely sound workmanship, we have yet to prove that reliability is necessarily incompatible with speed. America has made things move and has paid higher wages. Of course, her cost of living was high—I refer to pre-war-time conditions. The two factors, however, yield a quotient which favours our cousins very materially. Many politicians here attribute this result to the working out of America's fiscal policy; but one suspects that most politicians work to their briefs more slavishly than any advocate living. I feel confident this is no real explanation (by way of *obiter dictum*, however), but that it merely touches the fringe of the matter. Taking it all round, I think that on balance America stands to gain rather than lose, so far as cost of living is concerned, by an easing of the protective tariff; and admittedly there is a large, growing, and influential body of opinion there distinctly favourable to a *volte-face*.

In a previous article on "Reconstruction and Industry," I pleaded as well as I was able for carefully prepared plans, and a fair and adequate trial of their provisions. We are not working altogether in the dark. Those who urge most forcibly the vital need for increased production are keen and far-sighted students of economics, and many of them are employers of position and repute. Other countries have found that this principle is a fruitful one.

It can be made well worth our while to take the plunge. We can adapt ourselves. The war has given the lie to those who say we are too slow to live. We know we can speed up, simply because we have already speeded up. We have just to maintain our present high level of excellence. But if the workers do their part loyally, the masters must approve themselves no less worthily. It must be a concerted effort, and all grades and classes must add their quota. The success of each unit is part and parcel of the progress of the whole.

Without further preamble, I wish to direct attention in particular to the value and necessity of standardisation and stocking of machinery and parts.

One need reflect but little to realise how largely automatic and repetition work has functioned during the stress of war-time. In many directions, to accelerate delivery and increase output as required, it has been found absolutely imperative to cut down special features to a dead minimum, and to maximise the standard and semi-standard items. Many a firm, which formerly expended money and time lavishly upon trifling variations in design of non-essential parts, has insisted, and successfully, that a regular type be accepted. When necessity arises, it is surprising with what ease and how naturally we can adapt ourselves to entirely new conditions. A lady once wrote: "I accept the universe." This evoked Thomas Carlisle's caustic comment, "Gad, she'd better!" We have faced the inevitable with resignation, acquiescence, and courage. The inevitable has found us, and we have not merely accepted it; we have harnessed it into service; we have used it well. This has all been exemplified times without number during the past four years. Think what it means in organisation and plant. Operations are reduced in number and complexity, due to cutting out of many specialities—specialities are ever costly and confusing. There is simpler and more compact plant. Inter-communication is easier, and department can link up with department more naturally, more logically, and to far greater advantage. Work is turned out quickly, with increased precision, and at a relatively high return in cash value. It is almost a truism in engineering industries that the great specialisers whose products are diverse as the stars in magnitude, write down their capital drastically, while other firms turning out more or less standard articles of kindred class pay substantial dividends.

Of course, one cannot hope to standardise all things; nor would it be well to do so. But even where a machine *en bloc* may be a special make, many of its component parts can be good stock or even standard work. I think we might safely say it is advisable, wherever possible, to keep a large and various stock of standard parts, and to standardise as opportunity offers. Time spent on developing this side usually pays for itself many times over. In the haphazard, purely contingent method many firms adopt, this fact is often grievously overlooked. The system of such companies, if system it can be called, somehow finds itself—and, once found, if only it could be lost as easily so much the better for all concerned. Few there be who ever seriously think of making, of designing, a system; and yet a carefully-conceived and skilfully-worked-out programme is of the utmost importance. Without serious planning and forethought, it frequently occurs that a vast assortment of hybrid designs result, whose sole outstanding feature is their variety; and in many cases the differences are trivial and needless. With reasonable care and calculation, these possibilities would have been avoided; they are the logical and inevitable outcome of pitiful slackness. As it is, however, a close survey would often disclose the fact that these designs could readily be cooked down to a few leading types, each type embodying a limited number of sizes.

Even in the case of a manufacturing company which undertakes mostly special work, it is surprising how in later years, with comparatively small variation, many designs can be at least regularised if not actually made standard. Where large numbers of types already exist, while the mean differences may be small, the extremes will probably vary very materially. Hence, after criticism, and the consequent sifting out, several classes may prove to be quite satisfactory. These, if necessary, suitably modified, could be pressed into service either as separate units or as models for a sequence.

Specially in the days before us it will be necessary to stimulate and encourage production and the right kind of production. One of the factors making for success is undoubtedly the facility for standardisation. Repetition work, quickly done on simplified and compact plant, by larger numbers of workers, with improved inter-departmental communications—all this means a marked saving per man per hour; and then the completed machine can be offered on the market at as great a profit as before, but at a lower price, even after allowing for a reasonable increase in wages bills. This, all else being equal, should certainly encourage demand. And since successful trade is a nice balance between demand and supply, it would seem we have here the ground for real and general satisfaction. The public gets good value for its money, the manufacturer a reasonable price for his products, and the worker some approximation at least to a fair reward for his toil. Of course, one does not for a moment suggest that this provides a magical panacea for all industrial ills, but we certainly have what may bid fair to help matters forward once the opportunity be accepted. We know something of what community of hardship and suffering really means, we have discovered how much akin the most dissimilar among us really are; there has been the closest comradeship between most oddly assorted companions.

(To be continued.)

ARSENIOUS BOILER PRESERVATIVE: ITS MICROSCOPICAL FEATURES.

WRITTEN AND ILLUSTRATED BY JAMES SCOTT.

It is bad policy to tinker about with boilers in the hope of preventing or eradicating oxide, scale, scum, etc. The application of soda, lime, oatmeal, and other empirical remedies may prove efficacious when employed by very experienced, skilful, and careful engineers; but they either prove useless or inadequate in most cases. Zinc plates have their value in frustrating local action; yet they are themselves

liable to corrosion, and may eventually cause more trouble than they have hitherto checked.

It is far better to adopt a tested, proved, and highly efficient proprietary medium for the purpose mentioned, because there is a definite responsibility undertaken by the manufacturers, who would not proclaim the merits of anything they knew could not be trusted to properly fulfil its destined functions.

In dealing with the specific commodity named hereafter, it is not insinuated that nothing else will serve the same end as well. The reason for selecting it for present description is because it stands almost alone—unique, I might justifiably say—among boiler preservatives in its composition, character, and adaptability.

The substance is the Atlas "E" Boiler Preservative, and can be satisfactorily used for boilers, turbines, condensers, evaporators, feed heaters, refrigerator coils, and so on.

It is sold by The Atlas Preservative Co. Ltd., Windmill Lane Wharf, Deptford, London, S.E., and is a brownish, rather syrupy, liquid of heavy nature, its specific gravity being 1.600. It contains thirty (30) per cent of arsenious mineral matter, and must not, therefore, be put into boilers, or other vessels, intended for the distillation of drinking water. It is non-volatile, and does not pass over chemically in the steam; but it might occasionally get transferred mechanically into positions where it was not wanted. In the case of boilers and other contrivances devoted solely to industrial work it is perfectly safe.

While this preservative is beneficial to iron and steel, it is also wholly harmless in connection with the metal fittings, on which it has no effect whatever.

It is very efficacious in marine, locomotive, or stationary boilers. The preservative retains its qualities unimpaired for many years.

Corrosion in boilers is invariably set up by acidity, and we need not argue as to what extent galvanic action assists this process; nor need we worry about the possible impurities of the feed water. To avoid the effects of this acidity neutralisation must be undertaken.

The surface of new boilers may, and generally do, contain numerous minute particles of friable scale, loose, laminated metal, and scraps of dirt, which have been pressed firmly into the plates during the rolling treatment in the mills. This bloom is cast off when non-preserved boilers are occupied by hot water, and "bleeding" occurs, because the detached pieces are oxidised into iron oxide or rust, which colours the water red.

In this way the fibres of the plates become exposed to the corrosive influence of the acid-factors, and may get gradually covered with small blisters which break at the slightest touch, and reveal depressions and defective areas beneath them.

The sound metal is often permeated quite deeply underneath such places, with ramifying crevices; and these, in serious instances, will ultimately reach to the opposite side of the steel, and be responsible for great danger.

Progressive oxidation helps this particular form of corrosion, and is quite common in iron and steel. The oxygen may come from air, steam, or water. It has been proved beyond all doubt that the presence of oxide in the metal favours the more rapid oxidation of previously sound metal in the immediate vicinity.

The manner in which this and other gases are evolved can be understood by holding a glass of recently poured out hot or cold water up to the light. Tiny sparkling bubbles of gas will be seen adhering to the inside of the receptacle. In the boilers they adhere similarly to the metal, and are assisted to enter into combination with it owing to the action of heat. Hot steel draws such gases to itself, while the true water—the actual compound of oxygen and hydrogen, devoid of free or uncombined oxygen—is converted into steam.

To check corrosion and oxidation, it is customary to allow a thin coating of mineral scale to be deposited from the water; but it is frequently found that the rolling of the metal continues apace beneath it, until the time comes when it is necessary to institute repairs, or replace some of the parts.

The pitting hitherto referred to may proceed uninterruptedly below the scale, and become exceptionally pronounced, although it is not obvious because of the overlying scale. Oxygen, and other

FIG. 1.—One-thirtieth inch view, magnified, of arsenious preservative fluid, slightly warmed. Large crystals spring up rapidly in the substance.

gases, driven out of the scale may actually hasten the oxidation of the steel. Any grease which manages to get into the boiler from the lubricating sources, or by other means, will add immensely to the risks of priming, as the practical man will know quite well.

When scale becomes too thick and obstructive, and a remedy is set in operation to remove it, the fractures connected with the pitted portions are rendered naked, and leakage may follow. Such a result is thus not due to the work of the preservative, which has simply and commendably disclosed existing faults.

A light, porous mineral protective coating can be secured by judiciously using this preservative. This is much different to the dense, heat-multiplying, stony crusts which do considerable mischief. Badly-corroded patches in the steam spaces are remarkably cleared away after being painted over with this preservative.

It dissolves off undesirable scale, de-oxidises the oxide or rust, and detaches the scum, finally leaving

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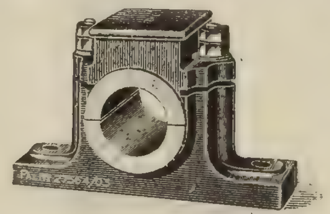

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0	..	1 0 13·0	2 0 26·0	3 1 11·0	4 1 24·0	5 2 9·0	6 2 22·0	7 3 7·0	8 3 20·0	10 0 5·0	0
1	0 0 12·5	1 0 25·5	2 1 10·5	3 1 23·5	4 2 8·5	5 2 21·5	6 3 6·5	7 3 19·5	9 0 4·5	10 0 17·5	1
2	0 0 25·0	1 1 10·0	2 1 23·0	3 2 8·0	4 2 21·0	5 3 6·0	6 3 19·0	8 0 4·0	9 0 17·0	10 1 2·0	2
3	0 1 9·5	1 1 22·5	2 2 7·5	3 2 20·5	4 3 5·5	5 3 18·5	7 0 3·5	8 0 16·5	9 1 1·5	10 1 14·5	3
4	0 1 22·0	1 2 7·0	2 2 20·0	3 3 5·0	4 3 18·0	6 0 3·0	7 0 16·0	8 1 1·0	9 1 14·0	10 1 27·0	4
5	0 2 6·5	1 2 19·5	2 3 4·5	3 3 17·5	5 0 25·0	6 0 15·5	7 1 0·5	8 1 13·5	9 1 26·5	10 2 11·5	5
6	0 2 19·0	1 3 2·0	2 3 17·0	4 0 2·0	5 0 15·0	6 1 0·0	7 1 13·0	8 1 26·0	9 2 11·0	10 2 24·0	6
7	0 3 3·5	1 3 14·5	3 0 1·5	4 0 14·5	5 0 27·5	6 1 12·5	7 1 25·5	8 2 10·5	9 2 23·5	10 3 8·5	7
8	0 3 16·0	1 3 27·0	3 0 14·0	4 0 27·0	5 1 12·0	6 1 25·0	7 2 10·0	8 2 23·0	9 3 8·0	10 3 21·0	8
9	1 0 0·5	2 0 13·5	3 0 26·5	4 1 11·5	5 1 24·5	6 2 9·5	7 2 22·5	8 3 7·5	9 3 20·5	11 0 5·5	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	0 1·04	0 2·08	0 3·12	0 4·16	0 5·21	0 6·25	0 7·29	0 8·35	0 9·37	0 10·42	0 11·46	0 12·5	

Weights of Lengths of Rolled Steel Sections.

Beam 6 in. × 3 in. × $12\frac{1}{2}$ lbs. per foot.

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Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	0 11 0 18	1 2 1 8	1 13 1 26	2 4 2 16	2 15 3 6	3 6 3 24	3 18 0 14	4 9 1 4	5 0 1 22	0
10	1 0 13	0 12 1 3	1 3 1 21	1 14 2 11	2 5 3 1	2 16 3 19	3 8 0 9	3 19 0 27	4 10 1 17	5 1 2 7	10
20	2 0 26	0 13 1 16	1 4 2 6	1 15 2 24	2 6 3 14	2 18 0 4	3 9 0 22	4 0 1 12	4 11 2 2	5 2 2 20	20
30	3 1 11	0 14 2 1	1 5 2 19	1 16 3 9	2 7 3 27	2 19 0 17	3 10 1 7	4 1 1 25	4 12 2 15	5 3 3 5	30
40	4 1 24	0 15 2 14	1 6 3 4	1 17 3 22	2 9 0 12	3 0 1 2	3 11 1 20	4 2 2 10	4 13 3 0	5 4 3 18	40
50	5 2 9	0 16 2 27	1 7 3 17	1 19 0 7	2 10 0 25	3 1 1 15	3 12 2 5	4 3 2 23	4 14 3 13	5 6 0 3	50
60	6 2 22	0 17 3 12	1 9 0 2	2 0 0 20	2 11 1 10	3 2 2 0	3 13 2 18	4 4 3 8	4 15 3 26	5 7 0 16	60
70	7 3 7	0 18 3 25	1 10 0 15	2 1 1 5	2 12 1 23	3 3 2 13	3 14 3 3	4 5 3 21	4 17 0 11	5 8 1 1	70
80	8 3 20	1 0 0 10	1 11 1 0	2 2 1 18	2 13 2 8	3 4 2 26	3 15 3 16	4 7 0 6	4 18 0 21	5 9 1 14	80
90	10 0 5	1 1 0 23	1 12 1 13	2 3 2 3	2 14 2 21	3 5 3 11	3 17 0 1	4 8 0 19	4 19 1 9	5 10 1 27	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t c. q. lbs.	Weight.
	5 11 2 12	11 3 0 24	16 14 3 8	22 6 1 20	27 18 0 4	33 9 2 16	39 1 0 1	45 12 3 12	50 4 1 24	56 16 0 8	

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 6 in. × 3 in. × 13 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	Ft.
0	..	1 0 18	2 1 8	3 1 26	4 2 16	5 3 6	6 3 24	8 0 14	9 1 4	10 1 22	0
1	0 0 13	1 1 3	2 1 21	3 2 11	4 3 1	5 3 19	7 0 9	8 0 27	9 1 17	10 2 7	1
2	0 0 26	1 1 16	2 2 6	3 2 24	4 3 14	6 0 4	7 0 12	8 1 12	9 2 2	10 2 20	2
3	0 1 11	1 2 1	2 2 19	3 3 9	4 3 27	6 0 17	7 0 25	8 1 25	9 2 15	10 3 5	3
4	0 1 24	1 2 14	2 3 4	3 3 22	5 0 12	6 1 2	7 1 9	8 2 10	9 3 0	10 3 18	4
5	0 2 9	1 2 27	2 3 17	4 0 7	5 0 25	6 1 15	7 1 22	8 2 23	9 3 13	11 0 3	5
6	0 2 22	1 3 12	3 0 2	4 0 20	5 1 10	6 2 0	7 2 7	8 3 8	9 3 26	11 0 16	6
7	0 3 7	1 3 25	3 0 15	4 1 5	5 1 23	6 2 13	7 2 20	8 3 21	10 0 11	11 1 1	7
8	0 3 20	2 0 10	3 1 0	4 1 18	5 2 8	6 2 23	7 3 5	9 0 6	10 0 24	11 1 14	8
9	1 0 5	2 0 23	3 1 13	4 2 3	5 2 21	6 3 11	7 3 18	9 0 19	10 1 9	11 1 27	9

Weight of Beam, advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight.	lbs. 1·08	lbs. 2·16	lbs. 3·25	lbs. 4·33	lbs. 5·42	lbs. 6·50	lbs. 7·58	lbs. 8·67	lbs. 9·75	lbs. 10·84	lbs. 11·92	lbs. 13·0	Weight.

Weights of Lengths of Rolled Steel Sections.

Beam 6 in. × 3 in. × 13 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft
Ft.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	0 11 2 12	1 3 0 24	1 14 3 8	2 6 1 20	2 18 0 4	3 9 2 16	4 1 1 0	4 12 3 12	5 4 1 24	0
10	1 0 18	0 12 3 2	1 4 1 14	1 15 3 26	2 7 2 10	2 19 0 22	3 10 3 6	4 2 1 18	4 14 0 2	5 5 2 14	10
20	2 1 8	0 13 3 20	1 5 2 4	1 17 0 16	2 8 3 0	3 0 1 12	3 11 3 24	4 3 2 8	4 15 0 20	5 6 3 4	20
30	3 1 26	0 15 0 10	1 6 2 22	1 18 1 6	2 9 3 18	3 1 2 2	3 13 0 14	4 4 2 26	4 16 1 10	5 7 3 22	30
40	4 2 16	0 16 1 0	1 7 3 12	1 19 1 24	2 11 0 8	3 2 2 20	3 14 1 4	4 5 3 16	4 17 2 0	5 9 0 12	40
50	5 3 6	0 17 1 18	1 9 0 2	2 0 2 14	2 12 0 26	3 3 3 10	3 15 1 22	4 7 0 6	4 18 2 18	5 10 1 2	50
60	6 3 24	0 18 2 8	1 10 0 20	2 1 3 4	2 13 1 16	3 5 0 0	3 16 2 12	4 8 0 24	4 19 3 8	5 11 1 20	60
70	8 0 14	0 19 2 26	1 11 1 10	2 2 3 22	2 14 2 6	3 6 0 18	3 17 3 2	4 9 1 14	5 0 3 16	5 12 2 10	70
80	9 1 4	1 0 3 16	1 12 2 0	2 4 0 12	2 15 2 24	3 7 1 8	3 18 3 20	4 10 2 4	5 2 0 6	5 13 3 0	80
90	10 1 22	1 1 3 6	1 13 2 13	2 5 1 2	2 16 3 14	3 8 1 26	4 0 0 10	4 11 2 22	5 3 0 24	5 14 3 8	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs. 5 16 0 8	t. c. q. lbs. 11 12 0 16	t. c. q. lbs. 17 8 0 24	t. c. q. lbs. 23 4 1 4	t. c. q. lbs. 29 0 1 12	t. c. q. lbs. 34 16 1 20	t. c. q. lbs. 40 12 2 0	t. c. q. lbs. 46 8 2 8	t. c. q. lbs. 52 4 2 16	t. c. q. lbs. 58 0 2 24	Weight.

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TRADE ITEMS, NOTES, &c.

The Fairfield Shipbuilding Co. Ltd., Govan, has contracted to build two steamers for the Anchor-Donaldson Line. Another contract which has just been reported is one for four cargo steamers for Messrs. Donaldson Brothers, to be built by Messrs. Scotts Shipbuilding and Engineering Co. Ltd., Greenock. The deadweight carrying capacity of each of these vessels will be 9,000 tons.

An electric melting furnace that may revolutionise the making of brass has, it is stated, been perfected by the United States Bureau of Mines, but it has not been put on the market for profit. It isknown as the rocking electric furnace, and patents have been taken out by the Bureau. Licenses to operate these furnaces under the patent can be obtained by American manufacturers of brass. The new furnace is the result of five years' experiments by the chemist of the Bureau, in co-operation with the Cornell University, the American Institute of Metals, and a number of manufacturers of brass.

New Method for Making Aluminium.—In a conference, recently held by the Christiania Society of Engineers, M. Goldschmidt described a new Norwegian process for the manufacture of oxide of aluminium by means of loam or potter's clay, which has the advantage of being very cheap. Already, in 1916, M. Collet, one of the directors, made experiments with the manufacture of oxide of aluminium by means of Norwegian raw materials. These researches were continued in 1916 and 1917, and yielded such excellent results that, in 1918, it was decided to open a factory at the Nidaros Tile Works, near Throndhjem. This factory has now been at work for 12 months, and several tons of oxide of aluminium have already been manufactured.

Platinum in Spain.—Following upon some prospecting work, undertaken at the initiative of the Spanish Government, after three years' research in various directions, it has been found that platinum exists at Serrana de Ronda to the extent of from 2 to 3 grams per metre. Serrana forms a chain of volcanic mountains extending over a distance of 1,400 sq. kilometres; hence they surpass the platinum found in the Ural Mountains, where the beds only cover an area of 50 sq. kilometres. It may also be mentioned that the reserves in the Urals never yielded more than ½-gram per metre; in addition to this, the beds there are now getting exhausted.

The English Electric Co. Ltd. has now gone to allotment. It will be remembered that this company, having arranged to acquire the whole holding of preference and ordinary shares in the Coventry Ordnance Works Ltd., and the Phœnix Dynamo Manufacturing Co. Ltd., made an offer to Dick, Kerr shareholders to exchange shares on certain terms. It is now announced that about 90 per cent of the Dick, Kerr shareholders have accepted the offer. The English Electric Co. Ltd. will control directly, or through Dick, Kerr and Co. Ltd., the following powerful group of manufacturing interests, viz.: The Coventry Ordnance Works Ltd.; Dick, Kerr and Co. Ltd.; Phœnix Dynamo Manufacturing Co. Ltd.; the United Electric Car Co. Ltd.; and Willans and Robinson Ltd. The company is registered with a capital of £5,000,000 in 1,500,000 £1 preference and 3,500,000 £1 ordinary shares, and the issued capital on allotment is just under £2,000,000.

A Census of Motive Power and Fuel Consumption Required.—A careful census of motive power and fuel consumption, said Sir Dugald Clerk, K.B.E., D.Sc., F.R.S., in his paper read before the Royal Society of Arts on March 19th, is urgently wanted in this country, and gas engineers note with pleasure the partial census of the Coal Controller's Department and the general interest of Parliament and the Prime Minister in our urgent fuel problems. They welcome the work of the Department of Scientific and Industrial Research in establishing the Fuel Research Board under the directorship of Sir George Beilby, and they also regard with interest the work of the Board of Trade Committee on the Water Power Resources of the United Kingdom. For the welfare of the country it is necessary that all sources of motive power should be fully investigated and all available power utilised.

the metal clean and bright. The solids are split up into fine, powdery matter, which either floats to the top of the water or (more usually) sinks to the bottom.

The purified surface will be either white, grey, brown, or some similar shade, according to the composition of the water.

When this preservative is used, zinc places can be

FIG. 2.—One-thirtieth inch view, magnified, of arsenious preservative fluid, showing another phase when heated, rhombic crystals then developing.

reduced to sixty (60) per cent, almost at once, and to a further fifteen (15) per cent, when all corrosive conditions have been eradicated.

The illustrations depict the identifiable characters of the preservative. Warm a film of it on a glass slide until a white ridge appears round it. Upon magnifying the substance, multitudes of tiny crystals of the shapes shown in Fig. 1 will be detected springing up in the still-fluid portions.

FIG. 3.—One-thirtieth inch view, magnified, of arsenious preservative fluid, after being heated until it becomes a firm crust. In this case various crystals are fused together.

By continuing the warming process for a few seconds, the majority of the crystals in the middle area will be of the shapes shown in Fig. 2, these approaching more nearly to the true octahedral ones which denote isolated arsenic.

The crystals are of various sizes, according to the degree of temperature experienced. Notwithstanding their apparent divergencies, they are all evolved from a kindred basis, continuous laminæ upon a rhombic core or nucleus producing boat-shaped, oval, and other modifications. It is advisable, in order to see their true elegance, to illuminate them from all sides from above, while the film containing them lies over a darkened ground.

If the solution is heated so thoroughly that it becomes quite solid through the evaporation of most of its fluid portion, the compacted mass is like Fig. 3, the crystals, pressed into one another, being very attractive. However hard and dense the crusts thus obtained may be (and they generally resemble layers of enamel) they are dilequescent, and invariably liquefy by drawing moisture from the air into themselves.

This last fact is advantageous, because it proves that the liquid will not, during use, produce any scale or defective areas on its own account upon the plates. It is obvious that if it automatically liquefies (with the assistance of atmospherical moisture) when it has been purposely solidified, it is incapable of becoming hard while associated directly with water or damp positions.

It would be hard to beat this preservative in respect of the numerous points for which claims have been made on behalf of it. But the engineer can himself test what has been said.

DRILL PROTECTOR.

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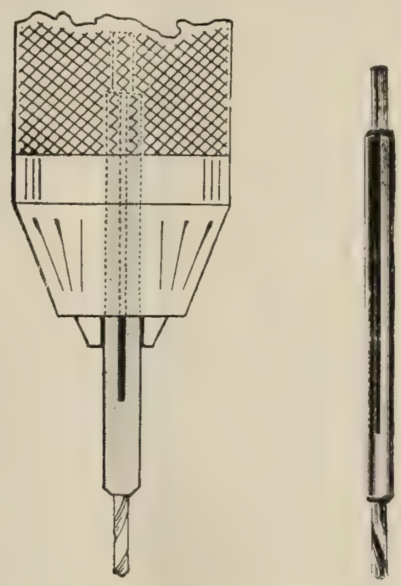
THE fracture of small drills is a thing every engineer wishes to avoid, and the problem that has for years baffled engineers and mechanics is to provide a simple and positive method of preserving these



DRILL PROTECTOR.

small size drills. It is, of course, easy enough to maintain their efficiency if excessive care is taken, but such drills are generally required for rapid work, and often are used in such tools as hand-drills, where great accuracy is not attainable.

The function of the Central Drill Protector is to

stiffen the shank of the drill, leaving exposed a length of the drill only sufficient for the depth of the hole to be drilled.

The protector consists of a length of hard brass drilled from one end to the other, and with about three-quarters of its length slotted on one side, the internal diameter being equal to the diameter of the drill to which it is to be applied.

To use the protector, the drill is inserted therein with the cutting point projecting from the chamfered end, the exposed length being equal to the required depth of the hole to be drilled. The split end of the protector is inserted into the drill chuck, so that it is secured for about half an inch of its length, the chuck then being tightened up in the usual manner.

If it is required to drill a hole of greater depth than usual, all that is necessary is to release the chuck and slide the protector farther up the drill for the extra length required, and then tighten up the chuck again.

A NEW THEORY OF PLATE SPRINGS.

By DAVID LANDAU AND PERCY H. PARR.

(Continued from page 253.)

Deflection of Springs.

The deflection of a spring has long been a favourite in engineering discussions as a means of verifying the old academic theory of the leaf spring. The practical deflection results having often been found to be in fair agreement with the academic predictions, they have frequently been urged as a confirmation of the theory (we may here mention that our theory shows that in general the deflection errors of the old theory are much less than the stress errors). The many discrepancies which did occur were explained by a series of carefully-phrased objections which apparently answered the purpose up to the present time. Thus we find that if the calculated deflection was smaller than that found on a test, it was easily explained as due to the friction of the leaves, or "modulus variation" of the steel, etc. As a matter of fact, carefully-conducted tests showed that none of the factors mentioned could explain the large differences often found between the "theoretical" and the "practical" deflections. The failure of the old theory is due to its real and inherent defects, and not to any imaginary variations of the material, etc. Thus, for example, the old theory supposed that the reactions are equal, which we have shown to be very far from the fact; it necessarily follows, therefore, that there must be analogous errors in the assumption for the deflection formulæ.

The old theory shows, for example, that the deflection of a two-leaf spring under a load of 2W is the same as that of a single-leaf spring under a load of W. Indeed, the old theory says that the deflection is inversely proportional to the number of leaves in the spring (supposing all to be of the same cross-section), or that it is inversely proportional to EI at the centre of the spring. The old theory does not consider the effect produced by changes in the length of the steps; it does not, in fact, consider the effect of the stepping at all. The mere mention of this fact is sufficient to show that the old theory is inadequate; a very serious error may easily be committed by ignoring the effect of the stepping on the deflection of a spring, as may be gathered from our fundamental equation (7), which shows that the deflection depends on the length of each and every plate.

For springs having all the leaves of the same cross-section, the deflection may be expressed by a simple formula as follows:—The fundamental relation of equation (7) becomes:

$$\partial_n = \frac{2W_n l_n^3 - W_{n-1}(3l_n^2 - 1l_n - l_n^3 - 1)}{6EI}$$

$$= \frac{W_n l_n^3}{EI}\left\{\frac{2 - \frac{W_{n-1}}{W_n}\left[3\left(\frac{l_{n-1}}{l_n}\right)^2 - \left(\frac{l_{n-1}}{l_n}\right)^3\right]}{6}\right\}$$

which is of the form

$$\partial_n = \frac{CW_n l_n^3}{EI} \quad \ldots\ldots\ldots\ldots\ldots\ldots(8)$$

where C represents the function in the brackets; we have calculated the values C for many cases, and these are given in Table III. As an example, if l, E, and I are constant, the deflection will be directly proportional to CW, and we will take W to be unity for a single-leaf spring, so that CW = 0.33333. Then for a two-leaf spring W will be 1.6 from Table II., and C will be 0.20313 from Table III.; so that CW = 0.32401, which is appreciably less than the 0.33333 for the single-leaf spring. For a ten-leaf spring we have 6.50 × 0.04813 = 0.31299, which is still less; the old theory says, however, that they would all be the same. At the same time, it will be noticed that the error of the deflection given by the old theory is much less than the error of the stress, as previously mentioned.

Now that we have established the fundamental relations, we propose to show other new relations of practical interest which our theory enables us to formulate.

We have seen that in the ordinary leaf spring with equal steps the reactions are not equal, and the stresses are not equal either. It may therefore occur to the reader that if it were possible to make the reactions equal we might also obtain equal

TABLE III.

Deflection Coefficients.

EQUAL SPACING.

K	$p=1$	$p=2$	$p=3$	$p=4$	$p=5$	$p=6$
1	.3333	.1667	.1111	.0833	.0667	.0556
2	.2031	.1233	.0894	.0703	.0580	.0493
3	.1456	.0986	.0755	.0614	.0517	.0447
4	.1130	.0822	.0654	.0545	.0464	.0410
5	.0924	.0706	.0578	.0491	.0427	.0378
6	.0781	.0618	.0518	.0447	.0393	.0352
7	.0676	.0550	.0469	.0410	.0365	.0328
8	.0596	.0495	.0429	.0379	.0340	.0308
9	.0532	.0451	.0395	.0352	.0318	.0290
10	.0481	.0413	.0366	.0329	.0299	.0274
11	.0447	.0385	.0343	.0310	.0283	.0261
12	.0404	.0355	.0319	.0290	.0267	.0247
13	.0373	.0330	.0299	.0274	.0253	.0235
14	.0347	.0311	.0283	.0260	.0241	.0225
15	.0325	.0293	.0268	.0248	.0230	.0215
16	.0306	.0277	.0255	.0236	.0220	.0206
17	.0289	.0263	.0243	.0226	.0211	.0199
18	.0273	.0250	.0231	.0216	.0203	.0191
19	.0260	.0238	.0221	.0207	.0195	.0184
20	.0247	.0227	.0212	.0199	.0188	.0178

stresses. The attempt would therefore be to question the effect produced by, say, for example, altering the steps, or changing the lengths of the leaves. To make the reactions equal in any spring is easily done by an application of the fundamental equation (7), which now becomes:

$$3l_n^2 l_n + 1 - l_n^3 - 2l_n^3 = 2l_n^3 - 3l_n^2 - 1ln + l_n^3 - 1$$

or

$$3l^2_n l_{n+1} = 5l_n^3 - l_n^2 - 1(3l_n - l_{n-1})$$

for, as the W's are now supposed to be equal, they naturally cancel, and for the present we are considering only leaves of the same cross-section, so that the I's are also equal. For $n=1$ this equation evidently becomes:

$$3l_1^2 l_2 = 5l_1^3 - l_0^2(3l_1 - l_0)$$

and the last term vanishes as before, since $lo=0$, and on dividing by l^3_1, there results:

$$3l_2 = 5l_1 \quad \text{or} \quad l_2 = \tfrac{5}{3}l_1$$

and this is the answer to the question proposed for the two-leaf spring.

The maximum bending moment in the short leaf is Wl_1, and in the master leaf is $W(l_2 - l_1) = 2/3Wl_1$. Now, since l_1 is three-fifths of l_2, the maximum bending moment on the short leaf is three-fifths of what it would be with a single-leaf spring, and, reciprocally, the strength of a two-leaf spring made to these proportions is $5/3 = 1^2/_3$ times that of a single-leaf spring, or $66^2/_3$ per cent more, when the reactions were made equal. This is greater than the strength of an equally stepped spring, because the bottom leaf is longer. Indeed, the longer the bottom leaf (after a certain minimum), the greater the strength of the spring.

We have calculated out Tables IV., V., VI., which show respectively the length of each plate necessary to secure equal reactions, the relative strengths of the various springs, and the deflection coefficients C for use in equation (8).

The general laws which the preceding study enables us to formulate with regard to non-tapered leaf springs are:—

1. In any leaf spring having leaves of equal cross-sections, and with equal steps, the reactions or pressures between the leaves continually decrease from the short leaf toward the master leaf, as do likewise the stresses.

2. In any leaf spring having leaves of equal cross-sections, and in which the reactions or pressures between the leaves are equal, the steps or overhangs continually decrease from the short leaf toward the master leaf.

In Fig. 9 we show graphically the result of making the reactions equal, and its effect on the stress distribution. The stresses are greatly altered, and are made uniform in the longer leaf for a distance of three-fifths of its length. This graphic analysis shows also why we can carry a greater safe load on this spring than on the spring with equal steps shown in Fig. 7, for we stress the main leaf more uniformly throughout its length, and so place a larger volume of metal at work; at the same time, the short leaf being longer, there is a greater total weight of metal in the spring, and actually the increase of strength is not in proportion to the extra

TABLE IV.

Overhangs.

EQUAL REACTIONS.

Plate No.	Overhang.	Sum of overhangs= length of top plate.
1	1.0000	1.0000
2	.6667	1.6666
3	.6312	2.2979
4	.6153	2.9132
5	.6061	3.5193
6	.6001	4.1194
7	.5958	4.7152
8	.5926	5.3078
9	.5901	5.8979
10	.5882	6.4861
11	.5866	7.0727
12	.5852	7.6579
13	.5841	8.2420
14	.5831	8.8251
15	.5822	9.4073
16	.5814	9.9887
17	.580,	10.5694
18	.5802	11.1496
19	.5797	11.7293
20	.5792	12.3085

TABLE V.

Strength of Springs.

EQUAL REACTIONS.

K	$p=1$	$p=2$	$p=3$	$p=4$	$p=5$	$p=6$
1	1.000	2.000	3.000	4.000	5.000	6.000
2	1.667	2.500	3.333	4.166	4.999	5.832
3	2.298	3.310	3.962	4.794	5.626	6.458
4	2.913	3.748	4.583	5.418	6.253	7.088
5	3.519	4.356	5.193	6.030	6.867	7.704
6	4.119	4.958	5.797	6.636	7.475	8.314
7	4.715	5.556	6.397	7.238	8.079	8.920
8	5.308	6.151	6.994	7.837	8.680	9.523
9	5.898	6.742	7.586	8.430	9.274	10.118
10	6.486	7.331	8.176	9.021	9.866	10.711
11	7.073	7.918	8.763	9.608	10.453	11.298
12	7.658	8.504	9.350	10.196	11.042	11.888
13	8.242	9.088	9.934	10.780	11.626	12.472
14	8.825	9.672	10.519	11.366	12.213	13.060
15	9.407	10.254	11.101	11.948	12.795	13.642
16	9.989	10.837	11.685	12.533	13.381	14.229
17	10.569	11.417	12.265	13.113	13.961	14.809
18	11.150	11.998	12.846	13.694	14.542	15.390
19	11.729	12.578	13.427	14.276	15.125	15.974
20	12.308	13.157	14.006	14.855	15.704	16.555

TABLE VI.

Deflection Coefficients.

EQUAL REACTIONS.

K	$p=1$	$p=2$	$p=3$	$p=4$	$p=5$	$p=6$
1	.3333	.1667	.1111	.0833	.0667	.0556
2	.1893	.1187	.0871	.0689	.0571	.0487
3	.1339	.0935	.0726	.0594	.0504	.0428
4	.1041	.0776	.0625	.0525	.0453	.0399
5	.0853	.0665	.0551	.0465	.0412	.0367
6	.0723	.0582	.0493	.0428	.0379	.0340
7	.0628	.0519	.0446	.0393	.0351	.0317
8	.0556	.0468	.0408	.0363	.0327	.0297
9	.0499	.0427	.0376	.0337	.0306	.0280
10	.0452	.0392	.0349	.0315	.0288	.0265
11	.0414	.0363	.0326	.0296	.0272	.0251
12	.0381	.0337	.0308	.0279	.0257	.0239
13	.0354	.0315	.0287	.0264	.0244	.0227
14	.0330	.0297	.0271	.0250	.0233	.0217
15	.0309	.0279	.0257	.0238	.0222	.0208
16	.0291	.0264	.0244	.0227	.0212	.0198
17	.0274	.0251	.0232	.0217	.0203	.0192
18	.0260	.0239	.0222	.0208	.0195	.0184
19	.0247	.0228	.0212	.0199	.0188	.0178
20	.0235	.0217	.0204	.0192	.0181	.0172

weight of metal, for the increase of strength is only 4.1 per cent, while the increase of weight is 6.7 per cent.

Observe in Fig. 9 that the *stresses are still the greatest in the short leaf*. It is impossible to alter this by merely changing the steps.

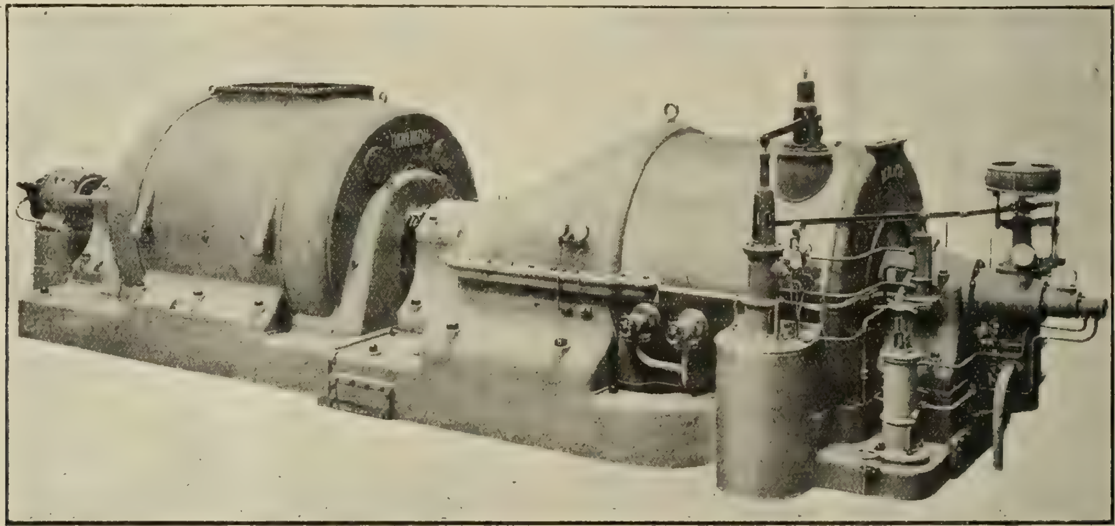
(To be continued.)

MODERN STEAM TURBINES.

By J. HUMPHREY.

(*Continued from page 273.*)

The speed of the turbine can be adjusted by hand by manipulating the small regulating wheel X, or if desired, the speed can be controlled from the switch-board with the aid of the small electric motor shown at W. When the load on the turbine is reduced to zero, either by means of the hand-wheel X or by the small electric motor W, only sufficient steam is allowed to pass into the machine to turn ringing until the attendant places the armature of the relay in its normal position. Each time the turbine is started the signalling apparatus operates, so that the apparatus cannot very well get out of order without the attendant being made aware of the fact. Normally, the oil pressure is somewhere between 55 and 75 lbs. per square inch, but the electrical device does not set the bell in action until the pressure drops to 28.5 lbs., and the main valve A does not begin to close until the pressure is in the neighbourhood of 22 lbs. per square inch. The pressure gauge which opens and closes the electrical contacts is connected to a point under the piston K. If desired, the auxiliary pump U can be made to start automatically when the oil pressure drops to about 50 lbs., but automatic control of this kind is only fitted to turbines of large types. Besides the safety devices described, the Oerlikon Company has recently introduced another safety arrangement for protecting turbines against excessive end-thrust, arising from water entering the turbine as the result of the boilers priming. This may give rise to water



STEAM TURBINES.—FIG. 83.

the rotor in its bearings, the valve B being almost entirely closed by the governor. If by any chance the valve B should stick, and so cause the speed to attain an abnormal rate, the emergency governor Q comes into action and shuts the turbine down. It has been explained that in the event of the oil pressure falling to 22 lbs. per square inch, the valve A closes, but in order to give the driver warning of a decreasing oil pressure, an electric alarm Y is provided. It consists of a pressure gauge, adjustable within the pressure limits of 7 to 28.5 lbs., and having sliding, adjustable contacts. These contacts are connected to a relay which in turn is joined to an electric bell and battery, with the result that in the event of the oil pressure dropping to a predetermined value, the electric bell rings, thus giving warning to the turbine attendant. If the pressure falls below 7 lbs. per square inch, the contacts of the pressure gauge break the relay circuit, but the bell circuit remains closed and the bell goes on hammer within the turbine casing which, in turn, may result in the production of a great end pressure on the rotor, and on the thrust bearing which has been known to be destroyed owing to this trouble. Clearly if the thrust bearing is destroyed the rotor is pressed by the steam towards the exhaust end of the turbine until the running discs come into contact with the diaphragms, and owing to the high speed at which turbines run, very serious damage may be done to the fixed and moving parts. The same trouble is apt to arise if for some reason the thrust bearing does not receive oil, and in order to safeguard turbines against damage of this nature, the Oerlikon Company is now fitting a device which shuts the main stop-valve in the event of the rotor shifting about 1-16th of an inch in an axial direction. It is claimed that no other firm has yet employed safety gear of this kind.

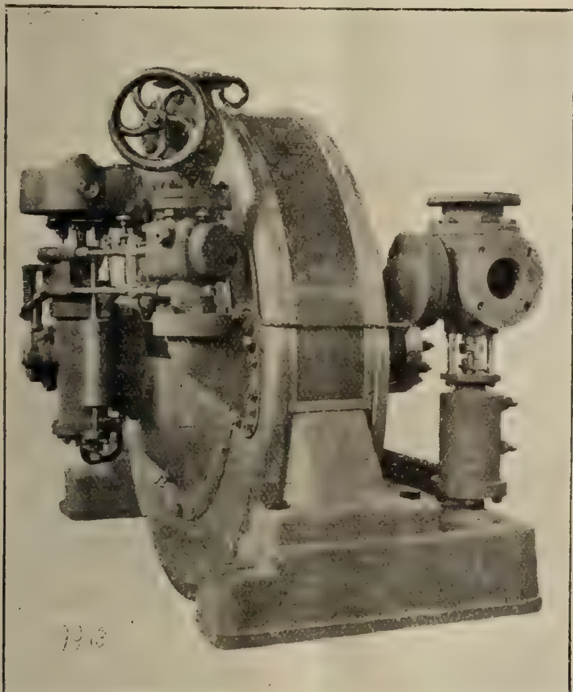
5,000 Kilowatt Turbine.

A complete 5,000-kilowatt Oerlikon turbine is

shown in Fig. 83. This machine is fitted with the safety devices for eliminating troubles arising from the want of oil and excessive speed, and the control gear previously described is to be seen on the extreme right. The overload valve, which admits steam a little nearer the exhaust than usual, when abnormal loads are called for, is to be seen on the top of the turbine, and is coupled to the end of the vertical rod A[1] in Fig. 82. The main stop-valve is to be seen at the right-hand corner of the illustration.

Small Oerlikon Turbine.

In addition to large turbines suitable for driving large electric generators belonging to power plants,



STEAM TURBINES.—FIG. 84.

the Oerlikon Company also builds small turbines suitable for driving circulating pumps, etc., and a machine of this kind is shown in Fig. 84. This is an impulse turbine of the single-wheel pattern with two rows of moving blades revolving at the sides of guide blades fixed into the casing. The governor, which is of the throttle-valve type, is driven by means of worm gear in the usual manner.

(To be continued.)

In view of the extended use of aluminium wires and ropes for overhead electric lines, the German Association of Electricity Works last October issued advisory notes as to the installation of such lines. It is very essential to keep the surface of aluminium intact; hence wires and ropes should not be dragged over stony ground or over sharp edges. Care should also be taken not to put on too high tension in stretching the wires. Contact between aluminium and iron is to be avoided; where that is impossible, pieces of aluminium foil should be interposed between the wire and the iron; iron wire should not be used in making attachments, but should be replaced by aluminium wire. Contact between aluminium and copper is still more to be guarded against, and where the two metals must be brought into contact, the moisture should at any rate be excluded, by varnishing the parts, or other means.

THE INFLUENCE OF IMPURITIES ON THE MECHANICAL PROPERTIES OF ADMIRALTY GUN-METAL.

By F. JOHNSON, M.SC., BIRMINGHAM.

(Concluded from page 246.)

THE AUTHOR'S EXPERIMENTS.

As already indicated, scarcity of material was one of the difficulties with which the author was faced. The ingots made, therefore, were small. They consisted of slabs cast vertically, and the test-pieces were all taken from the bottom, thus obviating the danger of the test-piece being affected by "piping." The dimensions of the slabs were ⅝ in. thick by 4 in. long by 3 in. deep. It is clear that, in an iron chill-mould, the rate of cooling such a thin section would be very rapid. So potent is this factor of rate of cooling that the risk of the influence of the added elements being obscured was great.

Therefore a second series of alloys was made, each alloy in this series being cast into a pair of exactly similar ingots, one of which provided a test-piece as cast, whilst the other provided a test piece which was annealed at 700 deg. Cen. for one hour, these conditions being similar to those recommended by Primrose. The longer time was allowed owing to the drastically chilling conditions under which the castings were produced. This chilling was more drastic than in the case of the first series. The results are given in the accompanying tables.

Owing to the small quantities of metal employed, no attempt was made to determine the temperature, but every care was taken to pour the metal at approximately similar temperatures. There was no case of the metal being poured at a dangerously high nor at a dangerously low temperature.

The percentage of zinc may be obtained by adding together the percentages of copper, tin, and impurity, and subtracting the total from 100.

The main features of interest in the results given in Tables V. and VI. are as follows:

1. They represent exploratory work, undertaken with the object of ascertaining which element or elements showed promise of utility in the manufacture of gun-metal castings, which exercised a benevolent neutrality, and which were actually detrimental.

2. From the point of view of mechanical properties, the results given by arsenic and antimony are not in accord with the views of the metallurgists as mentioned in the Note.

3. Nickel has a decidedly beneficial effect in series I., whilst in Series II. a remarkable increase in ductility is obtained.

4. Lead does not appear seriously to affect the mechanical properties, although it is possible the the resistance to shock is lessened.

5. Iron has a beneficial influence on mechanical properties, yield point, tensile stress, and elongation all being raised. Its effect on pouring qualities is bad, but much improvement is effected in this respect by the adition of a trace of aluminium.

6. The influence of manganese is bad in every way, the mechanical properties being adversely affected and the pouring qualities also. The surfaces of the castings were bad.

7. The annealing treatment goes far towards eliminating ill-effects produced by undesirable additions, notably aluminium and silicon. The general improvement brought about by annealing is remarkable.

The test results in Table VII. show how very important it is, for the purposes of strict comparison, always to cut the test-piece from the same section of the ingot. From ingot section 1 (Fig. 2) the results are far superior to those from section 2, the

TABLE V.—Series I.

Mark.	Analysis. Copper per Cent.	Tin per Cent.	Impurity per Cent.	Alloys as Cast (Chill). Yield Point. Tons per Sq. In.	Ultimate Tensile Stress. Tons per Sq. In.	Elongation per Cent. $C = 4\sqrt{\text{area}}$.	Brinell Hardness.	Remarks.
S	88·0	9·85	nil	11·7	23·15	19·0	...	
A	87·09	10·08	0·94 As	11·32	25·0	32·4	89	Metal fluid.
B	87·0	10·0	1·0 Al	12·75	22·65	9·55	95	Surface-skin on molten metal.
B¹	86·97	9·85	1·01 Al	13·55	22·9	9·55	100	Metal fluid, and very smooth surface on casting.
C	87·0	10·0	1·02 Sb	11·12	23·15	28·5	80	Metal fluid.
D	87·3	10·0	1·0 ferro-silicon	11·4	23·9	21·9	86	Metal a little viscous.
E	87·06	10·0	1·05 Ni	12·25	25·02	24·8	82	Metal fluid. Nickel added as 50-50 cupro-nickel.
F	87·28	10·05	0·67 Si	17·15	24·3	4·75	117	Very fluid metal.
G	87·18	9·99	1·02 Mn	14·1	22·9	14·3	89	Metal viscous.
H	86·72	10·4	0·35 Fe	16·8	27·1	21	96	Iron added as ferro-copper. Metal pours sluggishly. Castings scabby.
H¹	88·7	10·08	0·65 Fe 0·23 Al	16·3	27·8	18·1	...	Metal fluid.
I	87	10	1 boron-copper	12·15	23·8	18·1	80	...
J	86·98	10·08	1·0 Pb	12·25	22·1	21·9	80	Metal fluid.

TABLE VI.—Series II.

Mark.	Composition. Copper per Cent.	Tin per Cent.	Impurity per Cent.	Alloys as Cast. Yield Point. Tons per Sq. In.	Tensile Stress. Tons per Sq. In.	Elongation per Cent.	Brinell Hardness.	Alloys Annealed. Yield Point. Ton per Sq. In.	Tensile Stress. Tons per Sq. In	Elongation per Cent.	Brinell Hardness.
SR	88·0	10·0	nil	15·4	23·3	10·0	89	10·05	25·6	66	...
AR	87·0	10·0	0·9 As	15·8	23·4	5·5	100	10·18	26·05	69	74
B¹	86·97	9·85	1·01 Al	...	...	...	100	10·68	26·05	47	74
CR	86·97	9·97	0·8 Sb	15·6	20·95	5·5	96	9·57	24·7	52	65
ER	86·86	9·87	1·15 Ni	14·0	23·75	13 Broke on gauge mark	93	9·72	25·65	78	74
FR	87·2	10·2	0·7 Si	16·05	24·25	6·5	109	11·9	28·0	68	77
H¹	88·7	10·08	0·65 Fe 0·23 Al	...	...	...	100	14·85	29·3	55	...
JR	86·88	10·08	1·06 Pb	12·83	21·9	12·0	86	10·2	23·65	53	70

TABLE VII.—Alloys as Cast.

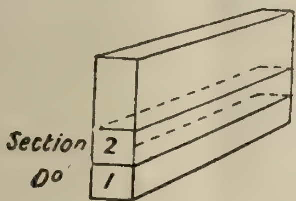
Mark.	Composition. Copper per Cent.	Tin per Cent.	Zinc. per Cent.	Impurity per Cent.	Ingot Section Number.	Yield Point. Tons per Sq. In.	Ultimate Tensile Stress. Tons per Sq. In.	Elongation per Cent. $l = 4\sqrt{\text{area}}$.
S	88·0	10·0	2·0	nil	1	11·38	22·30	18·0
S	88·0	10·0	2·0	nil	2	10·94	18·47	7·8
A	87·0	10·0	2·0	0·9 As	1	11·6	23·6	15·5
A	87·0	10·0	2·0	0·9 As	2	11·3	19·55	4·75
B	87·0	10·0	2·0	1·0 Al	1	12·75	22·65	9·55
B	87·0	10·0	2·0	1·0 Al	2	13·05	19·7	4·75
C	87·0	10·0	2·0	1·0 Sb	1	11·12	23·15	28·5
C	87·0	10·0	2·0	1·0 Sb	2	11·12	17·7	9·5
E	87·0	10·0	2·0	1·0 Ni	1	12·25	25·02	24·8
E	87·0	10·0	2·0	1·0 Ni	2	11·3	23·6	20·0

next section higher up, yet still far removed from "piping" effects.

A noteworthy feature is that the inferiority of section 2 is not nearly so marked in ingot E, containing nickel, as in the other ingots. Thus nickel seems to confer a double advantage:

(1) Improves the mechanical properties of cast and annealed specimens.

(2) The improvement extends to a greater proportion of ingot than in any other case.



Expressing the losses of mechanical values in section 2 as percentages of the values for section 1, the advantage conferred by nickel is strongly emphasised.

TABLE VIII.

Mark on Ingot.	Impurity.	Percentage Loss. Yield.	Percentage Loss. Tensile Strength.	Percentage Loss. Elongation.
S	nil	−3·8	−17·2	−56·7
A	arsenic	−2·6	−17	69·5
B	aluminium	+2·35 (gain)	−13	−50
C	antimony	nil	−23·3	−66·7
E	nickel	−7·7	5·6	−19·3

Tentatively the following are the chief results which may be expected from using the additions with which the author has experimented.

TABLE IX.

Impurity (not exceeding 1 per cent).	Effect on Mechanical Properties.	Effect on Fluidity and Surface Appearance of Chill Castings.
Aluminium	Hardening and embrittling	Good
Silicon...	Hardening and embrittling	Good
Manganese	Inappreciable	Bad
Arsenic	"	Good
Antimony	"	Inappreciable
Iron	Strengthening, without loss of ductility	Bad
Nickel	Toughening; increase of ductility	Inappreciable

The author would express his thanks to the staff of the Metallurgy Department of the Birmingham Central Technical School, particularly to Messrs. A. Thomas and W. N. Smirles, for their help, respectively in making the alloys and in carrying out the analyses.

(Concluded.)

In order to meet the increasing demand for Wild-Barfield electric hardening furnaces, new premises have been secured for works, and in future the works address of Automatic and Electric Furnaces Ltd. will be 281-283, Gray's Inn Road, London, W.C. 1.

Trade Items, Notes, &c.

In consequence of the fall in the price of lead, without any corresponding reduction in freights, labour, mining, and smelting requisites, the Fremantle Trading Co's. production in Western Australia, the directors say, does not pay, and the mines will be closed. Smelting will cease as soon as the stock of lead ores and concentrates on hand have been treated. The trading section of the company's business will be continued.

A paper read by Mr. T. J. Querette, of the North-East Coast Institution of Engineers, Newcastle-on-Tyne, shows that reinforced concrete vessels of 1,000 tons deadweight are 39 per cent heavier than steel vessels of the same size. With 2,000-ton ships the increase is 25.8 per cent; for 4,000 tons 16.5 per cent, and for 6,000-ton ships the increase in displacement falls to 11.8 per cent.

A number of contracts for tramway material have recently been placed with Messrs. Dick, Kerr and Co. Ltd., which, under the recent consolidation scheme embracing this and other firms, will now be carried out by the English Electric Co. Ltd. These include orders for tramway cars complete with equipments, and for car bodies, tramway motors, controllers, etc., from the Corporations of Nottingham, West Hartlepool, Morecambe, Southport, Brighton, Huddersfield, Bradford, Liverpool, Manchester, Burton-on-Trent, and others.

According to the *Boston Press* a $7,000,000 enterprise, the Norfolk-Hampton Roads Dry Dock and Ship Repair Corporation, Virginia, has been incorporated, and construction work upon a plant, which will be one of the largest of its kind in the United States, is about to be commenced. The site selected comprises 250 acres. Two docks are proposed, one having 10,000 and the other 15,000 ton capacity. The enterprise will, it is reported, have close relations with the Government in the matter of repairs to naval and other ships.

In 1912 the Indianapolis Light and Heat Co. constructed a concrete pit to contain 13,000 tons of coal submerged. Recently the company constructed a reinforced concrete coal pit holding 8,000 tons. The two pits have a total capacity of 20,000 tons submerged and 10,000 tons of coal above the water line, giving a 60-day supply if both pits are filled. The total cost of the two pits was $60,000, or $2 per ton of storage. The results of under-water storage have fully met the company's expectations, in that it prevented fires and preserved the heating value of the coal. Comparative tests of freshly-mined coal and coal which had been stored under water for approximately one year, from the same mine and the same vein, showed that the coal had lost during storage only 317 B.Th.U. out of 12,518 B.Th.U. per ton.

At a conference convened by the Victorian State Committee of the Advisory Council of Science and Industry to consider the question of engineering standardisation, on December 12th, it was unanimously resolved that in view of the importance of standardisation of engineering materials and methods, it was desirable that such standardisation should be considered for Australia as a whole; that in view of the fact that great progress has been made in Great Britain and the United States of America in such work of standardisation, it was desirable to accept such standards as had already been arrived at, provided they were satisfactory for Australian conditions; that in cases where British and American standards were equally applicable to Australia, it was desirable to select the British standards; and that it was desirable to establish in Australia a representative authoritative body to take the matter in hand, as a branch of the British Engineering Standards Association. Similar resolutions had been carried at conferences in New South Wales and Queensland.

Speed Trials of the World's Largest Oil Tanker.—The s.s. "San Florentino," the latest addition to the fleet of the Eagle Oil Transport Co. Ltd., successfully underwent her speed and other tests recently off the mouth of the Tyne, an average speed of 11.4 knots per hour being accomplished. The "San Florentino" carries a deadweight of 18,000 tons, and is the largest oil-tank steamer in the world; she is 546 ft. in length and 68 ft. 7 in. in width. Four and a half miles of oil pipes are fitted in the vessel, and the pipes are so arranged that four different grades of oil can be either loaded or discharged simultaneously without becoming mixed. The after and forward

pump rooms are each fitted with two powerful duplex pumps, capable of discharging 300 tons of oil an hour. The main suction pipes are 10 in. and the discharge pipes 8 in. in diameter. Suctions are fitted close to the centre-line of the ship, to enable the tanks to be thoroughly drained. Each suction is controlled by sluice valves, operated from the shelter deck. For discharging the oil there are nine outlets on each side of the ship. The propelling engines consist of a set of compound-geared turbines of the Brown-Curtis type, working a single propeller. The turbines work in series, but their connections are so arranged that they can each run independently and be coupled to gearing to work the propeller. In the casings of the turbines there is incorporated astern turbines capable of giving not less than 60 per cent of the total power for driving the ship ahead. Oil fuel burning apparatus is fitted to the boilers, which are cylindrical and five in number, with a working pressure of 220 lbs. per square inch.

THE INSTITUTION OF AUTOMBILE ENGINEERS.—A very interesting meeting of the Institution of Automobile Engineers was held on April 2nd, when Mr. Opperman read a paper on "Electric Vehicles." The leading idea appeared to be that the electric vehicle did not in any way trench upon the ground which can be covered by the internal-combustion and steam vehicles. It was very strongly laid down by those who had had experience of the electric vehicle, that its metier was for comparatively short journeys in towns and on good roads. The automobile engineer should not lose sight of the strong recommendation of one of the speakers that they should go carefully into the question of the construction of the electric vehicle as a side issue. Another good meeting of the Institution was held at Birmingham the following day, when Capt. Smith-Clarke described the difficulties experienced in tuning up aeronautical engines when these had been got on to quantity production. He finally upset the almost universally-held opinion that each motor has its own individuality, by pointing out that the difference in performance of apparently similar engines was due almost entirely to the fact that any two carburettor jets supposed to be of the same area do, in fact, vary between very wide limits. He went on to describe the methods adopted by the Aeronautical Inspection Department, for calibrating jets, and illustrated the instruments used, and also those used for reading the actual consumption in pints, per brake horse power per hour at any moment during the brake test. It is undoubtedly of great importance that the information collected by Capt. Smith-Clarke should be well known to automobile engineers. A very important step has been taken by the Council of the Institution in the imposition on all applicants for membership of an entrance fee amounting to £3 3s. in the case of members and associates, and £2 2s. in the case of associate members.

A POPULAR HANDBOOK: "PETROLEUM."—It is not every writer who has the gift of dealing with a highly technical subject in a popular manner, and making his subject not only easy, but of considerable interest. Mr. Albert Lidgett, however, has accomplished all these things in his handbook on "Petroleum," which has just been published by Sir Isaac Pitman and Sons, as one of their series of books on common commodities and industries. This volume takes the reader easily through such technical subjects as the origin of petroleum, with most interesting references to its earliest historical uses. A review of the world's oilfields contrasts the primitive hand-dug wells of Japan with the latest methods of drilling by modern steam plants, as now being employed in the search of oil in England, which is described and illustrated in a separate chapter. The uses of oil in peace and war as a fuel, as a lighting agent and as a heating agent, for internal-combustion engines, fuel oil burners, etc., are also described and illustrated. The leading enterprises are comprehensively reviewed, including reference to the Scottish shale industry. The last chapter contains the principal statistics of the oil industry brought up to date with 1918 figures. The story of the growth and romance of the petroleum industry is attractively told in this little volume, and its up-to-date character is evidenced by the fact that it records the launch of the world's largest oil-tanker, the "San Florentino," which took the water in December last. The ever-growing importance of petroleum and its manifold applications to all phases of life and commerce have created a widespread desire on the part of the "man in the street" to know something of the subject, and this little book at the modest price of 2s. 6d. nett will tell him the story of oil in a way which should ensure a very considerable sale.

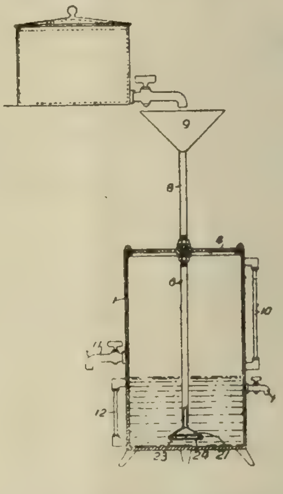
Patent Applications.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

ABSTRACTS OF SPECIFICATIONS.

RECOVERING WASTE LUBRICANTS.

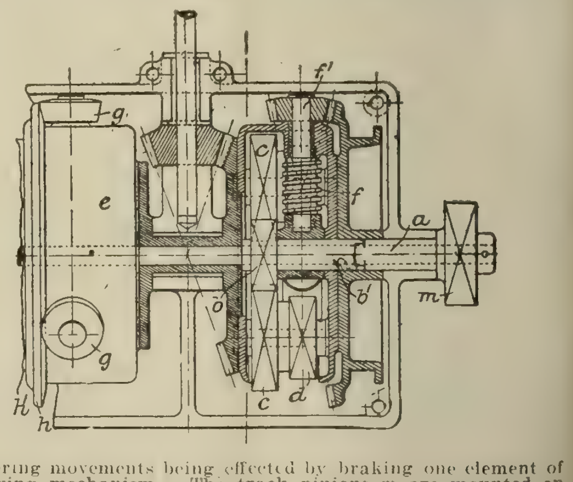
119,404.—E. BARRY, Power Station, Moore Park, Kilworth, Fermoy, Co. Cork. Mar. 22nd, 1918. Relates to apparatus for filtering oil and freeing it from water in which a funnel connected to a central tube is mounted on a vessel in which the oil is filtered and separated from the water by gravity. To the removable cover 4 of the vessel 1 are screwed two tubes 6 and 8. The tube 8 terminates in a funnel 9 and the tube 6 in an inverted funnel



21, in the mouth of which is placed a filtering disc 23 of wire gauze held in place by a split ring 24. The vessel 1 contains washing and cooling water and is provided with draw-off cocks 11, 13 for the oil and water respectively, and corresponding gauge-glasses 10 and 12.

MOTOR-VEHICLES.

119,563. G. M. BLACKSTONE, F. CARTER, E. CARTER and R. E. WATTS, Rutland Engineering Works, Stamford, Lincolnshire.—Oct. 22nd, 1917. Steering mechanism, more particularly for endless-track vehicles, and of the kind that operates by means of a differential drive, consists of an irreversible driving-mechanism comprising worm-gearing which normally drives straight ahead,

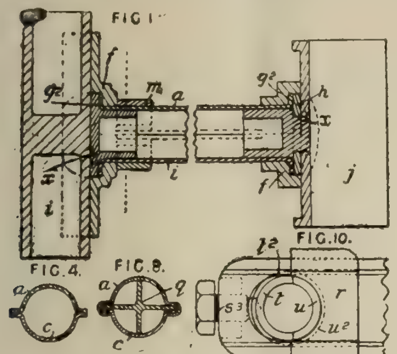


the steering movements being effected by braking one element of the driving mechanism. The track pinions *m* are mounted on sleeves *a* clutched to sleeves *b*1, on which sun wheels *b* are mounted. The sun wheels *b* engage planet wheels *c* co-axial with worm wheels *d* n mesh with worms *f* carried in a casing *e*. The worms *f* are mounted on spindles *f*1 having bevel gears *g* meshing with a gear *h* on a brake drum *h*1. The casings *e* are driven from the main shaft, and the drive to the track pinions *m* is normally solid, the track pinions being differentially driven by braking one or other of the brake drums *h*1.

CONNECTING-RODS.

119,542.—J. BURNAND, 103, Cambridge Road, Teddington, Middlesex.—Oct. 8th, 1917.—A connecting-rod for engines and pumps, par-

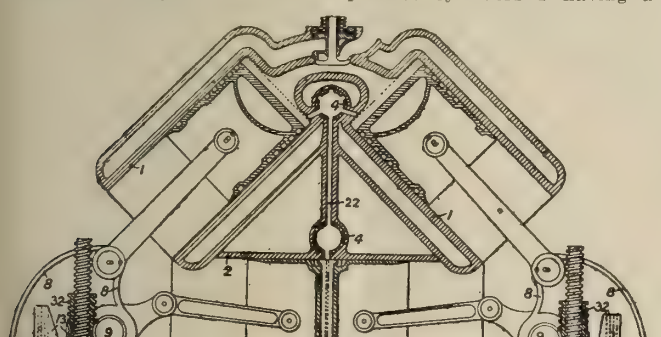
ticularly adapted for attachment to aluminium pistons, is formed of two or more metal strips secured together by spot welding or brazing, etc., the small and big ends being secured to plugs and sockets attached to the ends of the body. Figs. 1 and 4 show a rod, the body of which consists of two flanged steel strips a, c. At the small end, a flang $g2$ on the body is gripped between a flanged plug and a socket f. The latter is extended to form a bearing for the gudgeon-pin i, and all the parts are secured together and to the pin i by welding, etc. The end is strengthened by a two-part clip m. At the big end the plug x



is formed with a projection which is riveted to the end j, and the flange $g2$ is gripped between a washer h and the socket f. All the parts are secured by welding, etc. The body may have in-turned flanges, or consist of two parts of **D**-section, or as shown in Fig. 8, the body may have seamed joints and may be strengthened by ribs or by a plate a of flat or + section. flange $g2$ is gripped between a washer h and the socket f. All In the modified small end shown in Fig. 10, a two-part clip r is secured at a short distance from the end and the rod is bored transversely, partly through the clip r, to receive the gudgeon-pin bearings u, t. The latter are formed with flanges $u2$, $t2$ to engage the seamed joints, and are secured by welding, etc., and by a screw $s3$ tapped into a plug in the end of the rod.

INTERNAL-COMBUSTION ENGINES.

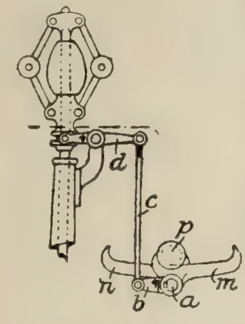
119,552.—P. CHALLIS, Beechwood, Kingswood, Surrey.—Oct. 15th, 1917.—To vary the piston stroke in an engine using a rocking-beam, the connecting-rod, *e.g.*, 15, Fig. 1, is adjustably secured to a beam having guide-ways upon which slides a slipper 13 carried by the rod. The beam oscillates about a fixed shaft 9 and the adjustment of the connecting-rod is effected by rotating a nut 32 in the interior of which works a screw 13 secured to the end of the rod. The driving mechanism is applied to a two-stroke-cycle engine in which a pair of cylinders 1 having a



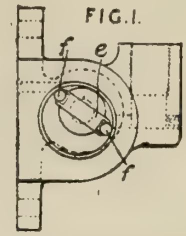
common combustion space is charged by a pump having oppositely-moving pistons 2 connected to a pair of rocking-beams 8. The nuts 32 for adjusting the screws 13 are actuated by worm wheels 20 on the shafts 9. The rotation of each shaft 9 may be effected from the crank-shaft through a pair of cone clutches which are combined with a screw device to prevent over-running. Rotary valves 4, driven at one-sixth the speed of the crank-shaft, are located one at each end of the pump delivery passage 22. Towards the end of the exhaust stroke, the lower valve 4 being closed, an air charge trapped between the valves is admitted to the cylinder for scavenging prior to the admission of the main charge.

SPEED GOVERNORS.

119,568.—S. H. SPARKES, Wardleworth, Wellington, Somersetshire.—Oct. 30th, 1917.—The action of a centrifugal governor is steadied by means of roller-weights p mounted on lever arms m, n fixed to a shaft a actuated by the governor sleeve. At normal speed, the weights are over the axis of the shaft, and are ineffective. When the sleeve moves from the normal position, one of the arms m, n is tilted down and the weight on this arm runs to the end of the arm and acts on the sleeve through the shaft a, arm b, rod c, and lever d.



Patent 119,568.



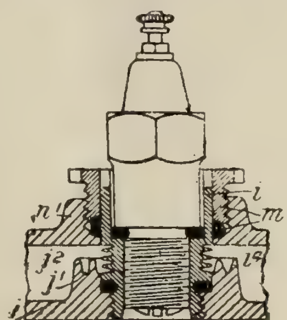
Patent 119,544.

ROTARY PUMPS.

119,544.—E. F. WALLIS, Digby Street, Kettering.—Oct. 9th, 1917.—The sliding vane e of a rotary pump having an elliptical casing is fitted with rollers f at its ends.

INTERNAL-COMBUSTION ENGINES.

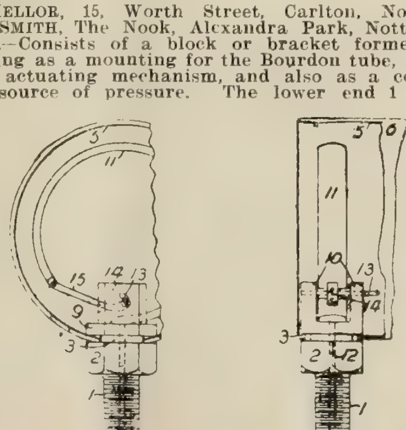
119,637.—MOTOSACOCHE SOC. ANON. and A. ISLIKER, 56, Route des Acacias, Geneva.—June 15th, 1918.—A spark-plug for water-jacketed engines passes through a water jacket into the socket i which is free to expand longitudinally and has cooling-gills $i4$ in contact with the water. In the form shown, the socket i passes through a stuffing-box m in the water jacket, and annular cooling-ribs $j2$ are formed on a raised bush j on the cylinder wall. Th gland of the stuffing-box may be screwed into or



bolted to the water jacket, or formed by turning over the upper edge of the bush $n1$. The jacket and cylinder wall may be connected by an integral bush surrounding the socket i and having holes for admitting water to the socket. In a modification, the socket is rigidly secured both to the cylinder and the water jacket, the latter being of thin sheet aluminium or the like to allow expansion of the socket.

PRESSURE GAUGES.

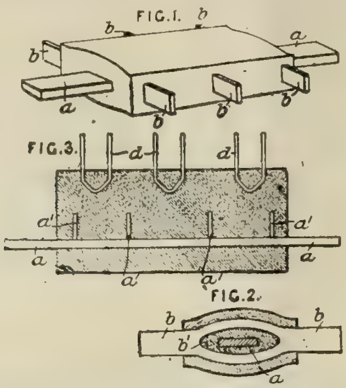
119,643.—A. MELLOR, 15, Worth Street, Carlton, Nottinghamshire, and R. SMITH, The Nook, Alexandra Park, Nottingham.—July 31st, 1918.—Consists of a block or bracket formed in one piece and serving as a mounting for the Bourdon tube, the index-hand and its actuating mechanism, and also as a connecting-piece to the source of pressure. The lower end 1 is screw-



threaded and formed with an hexagonal head 2; above this is a neck 3 to receive the casing, which is in two parts 5, 6 provided with slots engaging the neck 3. Above the collar 9, the block is formed with a slot 10, to the bottom of which is attached the tube 11, and in the upper part are mounted the index spindle 13 and the arm 14 connected by a link 15 with the outer end of the tube 11. In a modification, the spindle 13 is fitted with a pinion gearing with a sector pivotally mounted in the block.

ELECTRIC SWITCHES.

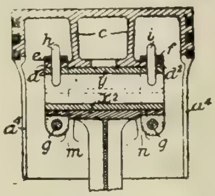
119,592.—G. O. DONOVAN and W. DONOVAN, 47, Cornwall Street, Birmingham.—Jan. 10th, 1918.—The spindle and, if desired, also the circuit-closing elements of an electric switch are moulded into the insulating-material. Figs. 1 and 2 show an arrangement



in which the circuit-closing elements *b* are provided with gaps *b*1 through which the spindle *a* passes; and Fig. 3 shows the circuit-closing elements *d* formed of U-shape and the spindle *a* provided with projections *a*1 by which it is anchored in the insulating-material.

PISTONS; CONNECTING-RODS.

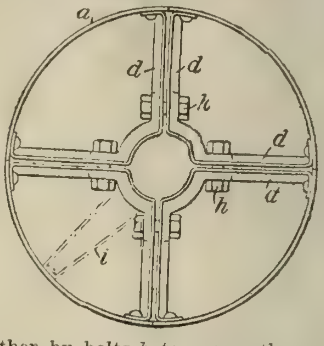
119,687.—J. BURNAND, 103, Cambridge Road, Teddington, Middlesex.—Oct. 8th, 1917.—In an aluminium or other piston for an internal-combustion, etc., engine, the segmental end *x*2 of the connecting-rod bears on a pin *y*, which is secured by pins *h*, *i* to



the segmental end *d*2 of a hollow central projection *c* of the piston. Split rings *e*, *f*, tightened by bolts *a*, embrace the ends *d*2 and *x*2 and are secured by the pins *h*, *i*. The skirt of the piston is split at *a*4, and may be of reduced diameter. The extension *d*2 is supported from the skirt by webs *m*, *n* which may be resilient.

DRIVING-PULLEYS.

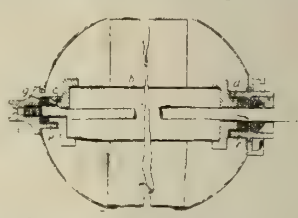
119,629.—A. GOODWIN, 56, Sumner Street, Southwark, London.—April 19th, 1918.—Driving-pulleys are built up from three or more strips *d*, which may be grooved longitudinally for stiffening and



are bolted together by bolts *h* to secure the pulley on the shaft or bush and are riveted to the sectional rim *a*. Additional stiffening-spokes *i* secured by the bolts *h* and riveted to the rim may be used.

RECIPROCATING PUMPS.

119,727.—J. E. WEBB, 11, Poultry, London.—Oct. 25th, 1917.—In a fire-extinguishing pump of the kind in which the barrel is revolubly mounted on the longitudinal axis of a cylindrical reservoir, so that the suction valves carried by the barrel will always



be immersed in the liquid, the barrel *b* is mounted in bearings *e*, *f*, in which it can rotate independently of the delivery pipe and pump rod. In one form, the bearings are provided in sockets mounted in the end of the reservoir *a*, and the socket *e* may be integral with the delivery nozzle *i*. Washers *g* are inserted between the socket and the bosses *c*, *d* on the barrel.

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CONTENTS.

EDITORIAL.

COMMERCIAL RESUMPTION.

THE result of the armistice and the permanent peace now imminent is seen in the readjustment and regrouping everywhere evident.

War-time production was divisible into three: firms who continued their normal business intensified but unaltered; firms who retained only a very small portion of their pre-war lines; and new firms who have been exclusively occupied with war material, who because they did not then exist have no traditional avocation to which they can return.

The change-over affects the first classification but little, they merely continue as before; plant, staff, and organisation complete are in being; without interruption or difficulty they continue the even tenour of their way with the minimum of disturbance. Even if they extend their activity and start new lines to supplement the old, there will be no revolution visible. Their speed full ahead is contingent mainly upon adequate raw material.

The second class have to demobilise and re-enlist, and have to reinstate plant peculiar to their original business where they elect to continue as before. The outstanding difficulty is that the pre-war organisation and staff have been amended, and while reputation will help, there is a strenuous time in front due to fresh competitors, whose chances of success are not greatly inferior to their own.

The last class present the most complex problem, in many instances they are casting about for suitable lines to make. Among these newer firms are very enterprising and shrewd concerns unhampered by tradition capable of first-class work of great refinement and precision. Started in many instances from patriotic motives, in others tempted by the undoubted opportunities open in national emergency, they have added greatly to productive resource.

It is a parting of the ways with a vengeance for all except those who have continued their normal occupation; it is not merely labour which is being demobilised, but plant and manufacture. There is no out-of-work donation for the firms who are in urgent need of light and guidance.

Unfortunately, re-absorption in the full tide of activity is slow, and as in the case of labour there is an unemployed pause between the two activities. The New Industries Committee Report has added very little in the way of advice to those with plant idle for want of something definite to make. Contracts entered into before the war are a source of trouble, in that although prices have advanced enormously, there is a tendency to take advantage of a clear right to execution at original prices, and no valid pronouncement on this vexed question has yet been made. It is being left to the accommodation and good sense of the contractual parties, and where the sense is wanting some rather pretty disputes are in progress.

Under conditions now ruling work has to be sought on a competitive basis instead of coming to the door, so to speak, and initiative, foresight, and enterprise are going to count as never before.

The firms who in pre-war days looked mainly to established reputation for business will have to look to their laurels, for there are hungry competitors in the field.

It is not altogether recognised that most successful firms began in a very modest manner; they started with meagre productive facilities, but with some one individual who understood some one line of business. In recent years this has gone a step further; there

are considerable firms who have no works at all, and come to some outside arrangement for the manufacture of their specialities in an exclusive field.

It is more the understanding of a particular scheme or device, combined with definite experience along a special line, than facilities for actual production, which have built up large concerns. It is a clear case of skill—directive skill of peculiar type—which is involved, not simply the ability to run a machine shop.

Special skill of this type was set aside to produce munitions of war; what has now to be raised is a resuscitation of latent ability for the munitions of peace. This, of course, leaves aside special opportunities afforded by re-conditioning, overhaul, thorough repair, and the utilisation of material and machines now in military occupation.

Restoration of commercial liberty by the removal of control and the free circulation of raw material now announced are precedent to full industrial resumption.

Other questions remain. It is essential to find an outlet and guidance for those firms started on war work now lapsed. The creation of a Works when work is unlimited for all is quite another question from the creation of a business upon a competitive basis, which is commonly developed slowly through a term of years and founded and evolved upon definite experience along a single line.

The further question as to whether high wages hamper export competitive trade is being warmly debated at the present time.

WATER POWERS IN GREAT BRITAIN.

INTERIM REPORT OF WATER-POWER RESOURCES COMMITTEE.

It is now generally recognised that the provision of abundant and cheap supplies of electrical energy will be one of the determining factors in the industrial and social future of the United Kingdom, on account of the ease with which electrical power can be applied to supplement and lighten the efforts of human labour in industry, in agriculture, and in domestic services. Up to the present time the motive-power requirements of Great Britain have principally been met by the combustion of coal, and it has been estimated that these requirements account for the consumption of about 80 million tons per annum. The nation's reserves of coal, however, are being consumed at the rate of approximately 240 million tons per annum, and are a wasting asset. On the other hand, rainfall, which is the source of all water-power, is constantly renewed, and when harnessed for the service of man represents a permanent asset.

In spite of the enormous developments that have occurred in other countries in the harnessing and utilisation of water powers, the progress hitherto made in this country has been small, although one or two notable developments have to be recorded, namely, those at Kinlochleven and at Foyers, in Scotland, and in North Wales. It is estimated that the water power harnessed in this country at the present time does not represent more than about 0.5 per cent of the total motive power employed for general industrial purposes.

There is little doubt that the plentiful supplies of cheap coal in this country have been mainly responsible in the past for the small amount of attention devoted to the question of the water-power resources of the United Kingdom. Even as recently as 1905, it was authoritatively, though erroneously, held that the total amount of water power in the British Isles was not worth considering in relation to the coal supplies, and that the total saving in coal which might be effected by the use of all our available water power would only be about 1,200,000 tons per annum. (Final Report of the Royal Commission on Coal Supplies, 1905, Cd. 2353, p. 16.) The recent investigations of the Water-Power Resources Committee of the Board of Trade, appointed in June, 1918, demonstrate that the conclusions arrived at in 1905 are very far from representing the actual position. It has now been shown that, upon the basis of the present average practice in coal-fired power stations in Great Britain, nine potential water-power schemes alone out of a large number existing in Scotland and in other parts of the country would represent an annual saving of 1,850,000 tons of coal if they were fully developed and fully utilised.

It first became clear to the Government that a systematic survey of the water-power resources of the United Kingdom was a question of practical importance through the investigations of the Nitrogen Products Committee, appointed in 1916 by the Ministry of Munitions. This Committee had to consider the prospects of obtaining large blocks of continuous power at a low cost, in order to decide whether certain nitrogen fixation processes were suitable for British conditions. In view of the promising character of a number of specific water-power schemes which were examined, the Committee recommended in December, 1917, that a thorough investigation should be made of the water-power resources of the country. This recommendation was brought to the notice of the Board of Trade, and the President decided, with the concurrence of the Minister of Reconstruction, to appoint a fresh Committee to go thoroughly into the whole question.

In the meanwhile, the subject was being examined from another aspect by the Conjoint Board of Scientific Societies, which appointed a Committee to report upon "what is at present being done to ascertain the amount and distribution of water power in the British Empire." This Committee issued a preliminary report in July, 1918, shortly after the appointment of the Water-Power Resources Committee of the Board of Trade, in which recommendations were made in regard to the necessity for a close and systematic investigation by the British and Imperial Governments of all reasonably promising water powers, and of their economic possibilities.

The Interim Report of the Water-Power Resources Committee, which is quoted in full below, deals principally with selected schemes in Scotland, but the Committee is fully alive to the possibilities in other parts of the United Kingdom. From the point of view of large water powers, the topographical features of England and Wales are less favourable than those of Scotland. In addition, it has to be remembered that the water resources of areas like the Lake District and Mid-Wales are already utilised to a considerable extent for the domestic require-

ments of large industrial towns in the Midlands and the North of England. Nevertheless, it is anticipated that the investigations now in progress will reveal the existence of a substantial aggregate of smaller water powers in England and Wales. The problem in Ireland is being dealt with locally by a special Sub-Committee. The Interim Report now published deals with only that portion of Scotland concerning which surveys and estimates are ready. The nine powers described are capable of generating a continuous supply of 183,500 electrical horsepower, corresponding with an output at the hydro-electric stations of 1,200 million Board of Trade units per annum. The Committee consider that these powers can be developed on a sound commercial basis, and that it would be entirely practicable to transmit the electrical energy developed at the water-power stations to industrial centres in Scotland. This Interim Report, which suggests the means by which British water-powers should be preserved as national assets, is issued as a Parliamentary Paper (Cmd. 75).

Text of the Report.

The Interim Report, which is addressed to Sir Albert Stanley, M.P., President of the Board of Trade, is as follows:—

The main purpose of this Interim Report is to bring to your notice certain practicable water-power schemes which may prove of assistance at once to the Board of Trade and to the Ministry of Reconstruction in providing employment for labour, not only on the works themselves, but also in consequent and auxiliary trades, such as quarrying, cement-making, steel constructional work, hydraulic and electrical plant manufacture, etc.

1. The Committee has already collected a very large amount of data, and taken evidence from a number of witnesses, while four well-known civil engineers have been retained for carrying out preliminary surveys in certain selected areas in Scotland and in North Wales. The evidence so far available to the Committtee indicate that there are considerable possibilities in other areas in Great Britain and Ireland, which still remain to be surveyed. The investigations required in Ireland will be carried out by the recently appointed Irish Sub-Committee.

Nine Scottish Water-Powers.

2. The reports in the possession of the Committee dealing with a portion of Scotland alone show that nine water-power schemes hereafter referred to are capable of generating a continuous supply of 183,500 electrical H.P. corresponding to an output at the hydro-electric stations of 1,200 million Board of Trade units per annum.

The importance of these schemes is further emphasised by the it is pointed out that in the year 1917-18 the whole of the steam power stations in Great Britain (public undertakings for electricity supply and for electric railways and tramways, but not private power plants) generated 4,628 million Board of Trade units and consumed 7.16 million tons of coal. Upon the basis of the present *average* practice at coal-fired power stations, the nine potential water powers thus represent the equivalent of 1.85 million tons of coal per annum.

3. In consequence of the modern developments in long-distance electrical transmission, it would be entirely practicable to transmit the electrical energy developed at these water-power stations to industrial centres in Scotland, for example, to Glasgow, the Clyde Valley, Edinburgh and District, Aberdeen and Dundee. Allowing for losses in transmission and transformation, the nine schemes in question could deliver at least 1,000 million Board of Trade units within a radius of supply of from 80 to 85 miles.

The magnitude of these schemes will be better appreciated when fact that the total number of Board of Trade units generated in the year 1917-18 by all the steam power stations in Scotland (including public utility undertakings, but excluding private power plants), amounted to about 537 million, and involved the consumption of over 806,000 tons of coal. If the nine water-power schemes were fully developed, they would therefore be capable of supplying about double the present output for power, traction, and lighting purposes in Scotland.

4. As an alternative outlet for a part of this large amount of power, industries dependent upon considerable blocks of cheap power, for example, the manufacture of carbide or calcium cyanamide, or other electro-chemical or metallurgical processes, could be established close to those of the water-power stations which would be conveniently situated as regards railway and water transport.

5. The Committee desires to emphasise the fact that the whole of this potential water-power, which, as shown later, can be developed for the use and convenience of man at a commercially sound cost, is now running to waste. The value of these powers is brought into greater prominence by the continuous increase in the price of coal.

Estimated Cost of Development.

6. The nine Scottish schemes are briefly described in the following table, and their positions are shown on the accompanying map. [This map is printed in the Parliamentary Paper.] A full report upon each scheme is in the possession of the Committee.

Group.	Scheme.	Size Continuous E.H.P.	Estimated Capital Cost. Total £	Per E.H.P. at power house. £	Approximate number of men required on the sites. 1st year to 3rd year.
A.	Loch Laggan ... ,, Treig	38,000	1,742,000	45·8	2,000—3,000
B.	,, Ericht ... ,, Laidon ... ,, Rannoch... ,, Tummel ..	42,000	1,580,000	37·6	2,000—6,000
C.	,, Quoich.... ,, Loyne	27,000	1,069,000	39·5	1,000—3,000
D.	,, Clunie ... R. Moriston	9,200	393,000	42·8	500— 900
E.	Loch Monar	7,200	315,000	44·0	250— 750
F.	Lower Farrar ...	7,600	288,000	38·0	250— 750
G.	Loch Affric .... ,, Mullardoch	31,000	1,133,000	36·5	750—3,250
H.	Kilmorack Falls.	9,500	160,000	17·0	250
I.	Loch Awe ...... ,, Nant	12,000	395,000	32·9	500—1,000
	Total..........	183,500	7,075,000	38·5 (av.)	

[NOTE.—Except in the case of Scheme A, the figures for the capital cost do not include an allowance for interest on capital during construction. This item would represent an addition of $7\frac{1}{2}$ per cent to the separate totals.]

(*To be continued.*)

With the object of eliminating risks due to the presence of electric cables in the operating shaft, the Anaconda Copper Co. has driven $3\frac{1}{8}$ in. diamond drill boreholes through the solid rock to lead the cables into the mine. The cables are protected by $\frac{1}{8}$ in. lead, 0.18 galvanised steel wires, and are 2.03 in. outside diameter. Current for over 3,000 H.P. is transmitted in this way.

The English Electric Co. Ltd., in which are now consolidated the interests and activities of the Coventry Ordnance Works, Dick, Kerr, Phœnix Dynamo Manufacturing Co., United Electric Car Co. and Willans and Robinson, have recently secured an order for a second 18,750-kw. turbo-alternator set for the Glasgow Corporation. The contract includes, in addition to the turbo-alternator set, condensing plant and step-up transformers. The turbine will be a single-unit machine of the firm's standard type, arranged to run at 1,500 r.p.m., and will operate on steam at 250-lb. pressure, superheated to 650 deg. Fah., and exhaust into a vacuum of 29.1 in. It will be coupled to a 6,500-volt, 25-cycle, three-phase alternator, having a maximum continuous rating of 24,000 k.v.a. at 80 per cent power factor.

KNOTTING AND SLINGING: HINTS FOR ERECTORS.

By F. R. Parsons.

Doubtless every mechanic can knot and tie a rope or sling and carry a casting, or a piece of machinery, but few can explain intelligently the principles underlying the more common forms of knots used by engineering erectors, or put forward reasons why a

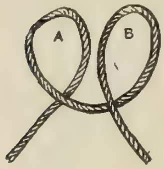


Fig. 1.

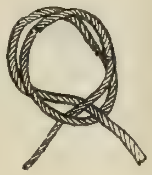


Fig. 2.

Fig. 3.

sling should be applied in a certain position or manner, and not in others.

Double Half-Hitch.

Almost all knots used in engineering practice are more or less developed adaptations of the double half-hitch seen in its commencing form in Fig. 1. By bringing the two loops A and B together, B under A, the completed knot as in Fig. 2 is formed.

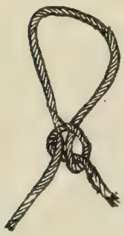


Fig. 4.

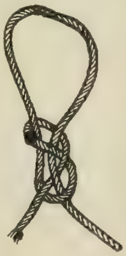


Fig. 5.

Fig. 6.

In Fig. 3 is shown an example of this form of knot as applied to the loose end of a guy rope attached to a bar or stake driven into the ground. This is used largely in rigging up derrick tackle, or staying poles or gallows.

Slip Knots.

The running or slip knot is shown in its simplest form in Fig. 4. A bight is first formed, then an

Fig. 7.

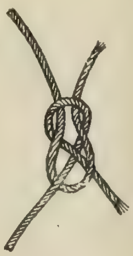


Fig. 8.

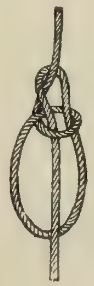


Fig. 9.

overhand knot made with the end drawn round the starting point. A development of this form of knot is shown in Fig. 5, this type making for increased safety in that the loose end is not so likely to be drawn through when the strain is applied.

Joining Ropes.

The wrong and right way to join two ropes, or two rope ends together, are shown respectively in Figs. 6 and 7. The first of the two illustrations represents a "granny" or "lubber's" knot, and is bad and unsafe both in principle and application,

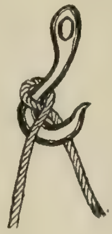


Fig. 10.

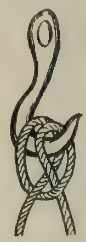


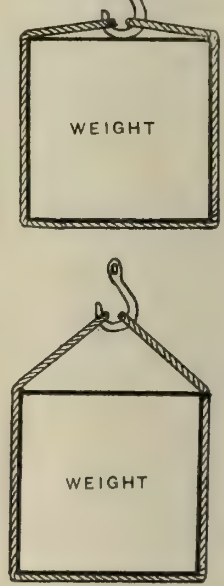
Fig. 11.

since tension applied to the rope ends tends to withdraw the loose ends of the rope out from the knot. The correct knot, shown in Fig. 7, is as perfect as a knot can be, and can be made and undone with equal rapidity, and no amount of tension will tend to unlock it.

Weaver's Knot.

That shown in Fig. 8 is known as the weaver's knot, or thumb knot, so called because in the operation of tying the end held in the right hand is passed over the thumb of the left. It is also the

Fig. 12.



Figs 13 and 14.

most favoured knot used by weavers when mending the broken ends of their yarn. It is equally good in a rope, and, when correctly tied, is perfectly safe.

Bowline Knot.

The bowline knot is illustrated in Fig. 9. The end is first laid back over the standing part of the rope so as to form a loop, and then passed up through the loop, round the back of the standing part, and again through the loop. This is a very useful knot in erecting, perfectly safe if required to sling a man for any purpose, or for hanging on a standing rope a set of blocks or luff tackle. It may also be used as a running knot.

Slinging.

Coming now to the various methods of slinging, in which the use of ropes play an important part, Fig. 10 shows a ready way of securing a rope temporarily to a block. The method of making this hitch is evident from the illustration, and though ridiculously simple, and perhaps unreliable in appearance is, nevertheless, perfectly safe, as the standing part when hauled upon, or weight applied to it, jams the end firmly against the back of the hook.

Clove Sling.

The clove, or double half-hitch, shown in Fig. 11, offers a ready and convenient method of attaching a

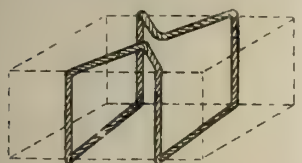


Fig. 15.

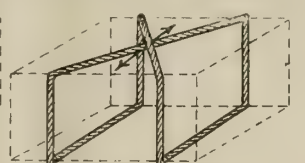


Fig. 16.

rope middle to a hook when its ends are not free to form any other type of attachment.

Slinging a Bar.

Fig. 12 illustrates a perfectly safe method of slinging a bar, a shaft, or a length of shafting when it is desired to lift or sustain it vertically. If tied as shown, that is, with a double half-hitch, then a single hitch, slipping is well nigh impossible.

Using a Sling.

Figs. 13 and 14 are interesting to the engineer or erector because it is intended to illustrate the right and the wrong method of using a rope sling when it is desired to handle a heavy weight—a casting, or

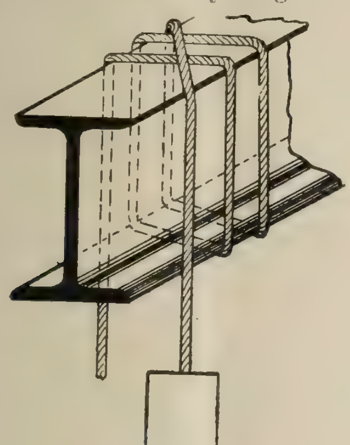


Fig. 17.

a piece of machinery—and the means for doing so are limited. Assume a rope sling around a weight, as in Fig. 13. If the sling is so short that the conditions illustrated obtain, then the tension on each side of the sling would be nearly three times that of the whole weight of the load. Therefore a rope sling would require to be used having three times the breaking strength than there would be necessity for. The way to handle this with safety, so that the tension on the rope would not be exceeded, would be as shown in Fig. 14, the inclination of each side of the rope to the vertical being in the neighbourhood of from 60 to 70 degrees.

Figs. 15 and 16 show two methods of using a rope sling. The second method is far preferable to the first, since in this there is less danger of the load slipping through or out of the sling. A further precautional feature is to couple the hook to the sling, in the direction shown in Fig. 16 by the double

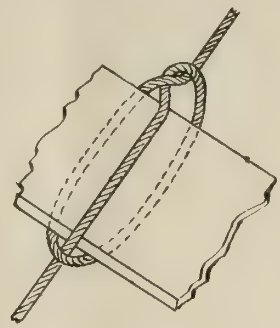


Fig. 18.

arrow, through the crossed upper portion of the sling, and not the reverse way, since such a method might result in slip.

Sustaining a weight by means of a rope slung over a joist or a girder can be safely accomplished without the need for knotting or fastening, provided it is carried out as indicated in Fig. 17, where it will

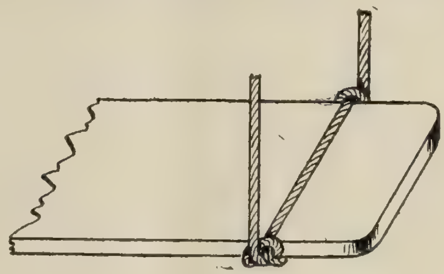


Fig. 19.

be seen that any weight applied to the fall of the rope tends to lock the coils passed around the fixed object.

Slinging a Plank.

Fig. 18 illustrates a method of slinging a plank from a roof or a joist for use as a stage. The plank is passed through a bight in the rope, then the ends of the latter brought tightly up at each end so that the single rope lies on the top of the plank, the double part of the sling being underneath, as indicated in Fig. 19.

THE INSTALLATION AND OPERATION OF STATIC TRANSFORMERS.

By F. Ashton.

(Concluded from page 255.)

Testing Diametrical Connections.

When the diametrical connection is used for joining up transformers to six-phase rotary converters, each transformer has only one secondary, as illustrated in Fig. 20 in *The Industrial Engineer* of Dec. 21st. To make the connections in this case is a simple matter, but there is a possibility of getting wrong rotation and a reversal of phase. In Fig. 25 the three secondary windings are shown at A B, C D,

and E F, and to test for a reversed phase the windings should be connected up at B and C and D and E. The primary windings should then be energised, when on connecting a voltmeter across A and F, a zero reading should be obtained. In joining up the transformers to the slip rings, it is necessary to see, in this case, that corresponding ends of the secondary windings of the three transformers make connection with tappings on the armature 120 deg. apart, and, further, that the two ends of each secondary are connected to tappings 180 deg. apart, as shown in Fig. 20 in *The Industrial Engineer* of December 21st, where the numbers below the slip rings correspond with the tappings 1, 2, 3, etc., around the armature. It will, of course, be understood that on a multi-

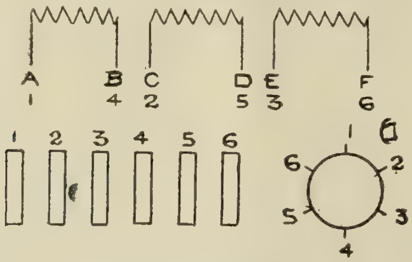


Fig. 25.—Diagram showing the Method of Making Diametrical Connections.

polar converter the tappings are duplicated for each pair of poles. Instead of testing for a reversed phase in the manner described above, the test may also be made by connecting three corresponding ends of the transformer secondaries to their slip rings, whilst the three other ends remain free. On energising the primary windings (not shown in Fig. 25), voltages will be induced in the secondaries, for under these conditions they are obviously connected star fashion, with the armature of the rotary converter at the neutral point, and it is clear that if none of the transformer windings are reversed, three separate pressure readings taken across each phase in the ordinary way—that is, across the free ends of the secondary windings—should give readings equal to 1.73 times the voltage of each individual secondary winding. If one or more of the phases are reversed, this result will not be obtained, and the voltage vectors will be 60 deg. apart, instead of 120 deg. apart. Having ascertained that none of the phases are reversed, it then remains to test for correct rotation. The ends of the secondary windings that have been connected to the slip rings should not be interfered with, and the three remaining ends should be connected to the three other slip rings through lamps. With the primaries of the transformers energised, and the converter running, the three lamps should light up and become dark simultaneously. If this does not happen, it will be necessary to cross corresponding ends of two of the secondaries, such as A and C and B and D in Fig. 25. If no test has been made with a view to discovering whether there is a reversed phase, two lamps may light up together, whilst the other lamp lags half a cycle behind, the latter lamp being connected to the phase that is reversed. If there is a reversed phase as well as wrong rotation during one half of a period, the lamps will light up one after the other, whilst during the other half of the period they will be dark. Other results may be obtained if the secondary leads are joined up so that the ends of any given secondary do not join up with points on the armature that are diametrically opposite. It will suffice to say that the permanent connections must not be made until all the lamps light up and become dark simultaneously. The correct connections for three-phase rotary converters can also be arrived at by connecting lamps across the switches after the mesh connection of the secondary windings have been tested for a reversed phase.

Transformer Tappings.

In practice, high-voltage transformers are frequently provided with tappings on the primary windings, the object of these tappings being to compensate the line drop, for by connecting the incoming cables to these tappings, instead of to the extreme ends of the high-tension windings, the secondary pressure can be raised. It is obvious, however, that in the case of step-up transformers at the generating end of a system, tappings are not required. At the receiving end of a system (a sub-station, for instance), tappings provide a simple and convenient means of compensating the line drop. With a 10 per cent drop in the line, for example, the 10 per cent tapping can be brought into use and the correct secondary pressure can be attained. Clearly, this tapping would be used at times of heaviest load, and the current capacity of the high-tension windings should correspond with the current due to the lower working voltage. Designers often rely on the ordinary windings to deal with the increased current, although the capacity of the transformer is based on the full-rated voltage. Transformers are also often provided with tappings on the low-tension side for starting rotary converters at reduced voltage, a throw-over switch being provided for changing from one set of tappings to the other. The connections

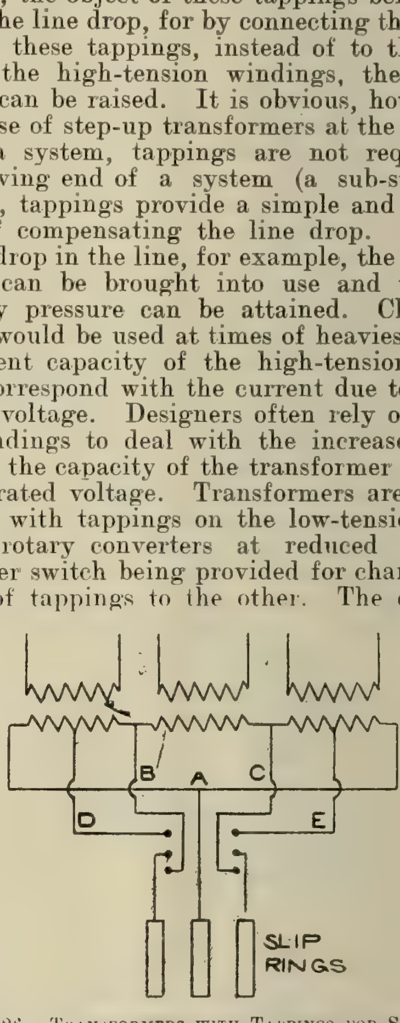


Fig. 26.—Transformers with Tappings for Starting a Rotary Converter.

for three transformers feeding a three-phase rotary converter and having tappings for starting are shown in Fig. 26, leads A, B, and C giving the full voltage, and A, D, E half-voltage. When the switch is thrown on to the top contacts, half-voltage is applied to the slip rings, whilst when the switch is thrown on the top contacts full pressure is applied.

Transformers in Parallel.

It has been shown that, when paralleling to single-phase transformers, it is a simple matter to ascertain whether they have the correct polarity with respect to one another. All that is necessary is to connect one secondary lead of one transformer to a secondary

lead of the other transformer, and then to connect the remaining two leads together through a fuse. If the fuse does not blow, it may be concluded that the polarity is correct, and the transformers may be joined in parallel without the fuse, care being taken not to reverse the connections. If the fuse should blow, a reversal is, of course, necessary. When operating three-phase transformers, or banks of three single-phase transformers joined up for three-phase working, it is necessary to ensure that the phase relations of the voltages of the two banks of transformers are the same both in respect to position and direction. It is impossible to parallel a bank of transformers connected in mesh on the high and low-tension sides with another bank of transformers connected in mesh on the high-tension side and star on the low-tension side, or *vice versa*. But if one bank of transformers has its high and low-tension windings mesh connected, it can be worked in parallel with another bank having all its windings star connected. Also a bank connected mesh star fashion can be paralleled with a bank connected star mesh fashion. Transformers joined up in mesh on the high and low-tension sides, and transformers joined up in star on the high and low-tension sides, are both capable of being connected so that there is no angular displacement between the high and low-tension voltages, or so that there is an angular displacement of 180 deg. In the third case, where one group of transformers has its coils mesh star connected, and the other group its coils star mesh connected, the angular displacement between the high and low voltages is 30 degrees in each instance. In all these three cases, therefore, it is possible to work the banks of transformers in parallel, because it is possible to make the angular displacements between the high and low-tension voltages equal. In other cases where this state of equality cannot be attained, parallel operation is impracticable. Successful parallel operation depends, however, not only upon the position and direction of the voltages, but also upon the correct voltage ratios of the transformers. Even if the voltage ratios are only slightly different, the local current set up in the windings, as the result of the inequality of voltage, may be considerable. This local current is due to the difference in the two voltages divided by the impedances of the transformers, and it adds to the load current in the transformer having the highest voltage, and subtracts in the other transformer, and the former therefore carries the highest load. When transformers are connected in delta, unequal voltage ratios will give rise to unbalanced voltages, and local circulating currents will be set up in the high and low voltage coils. If, however, the supply voltages be unbalanced, unbalanced currents cannot be set up in the mesh connectings owing to this. The actual local circulating current in a bank of mesh-connected transformers, due to unequal voltage ratios, can be arrived at in exactly the same way as with parallel-operated single-phase transformers, that is to say, by dividing the voltage difference by the total impedance of the transformer bank, the impedance of a transformer being found by impressing a voltage on the low voltage winding with the high-voltage winding short-circuited. The current is then read, and when divided by the impressed voltage, gives the impedance. When transformers are connected star fashion, a slight difference in the transformation ratio makes little difference as compared with the results obtained with mesh connected transformers, owing to the shifting of the neutral point, causing an equalisation of the voltages. The impedances of transformers operated in parallel, should be in inverse proportion to the load they have to deal with, in order that the voltage drop from no load to full load may be the same in all the transformers, both in respect to phase and magnitude. The impedance is, of course, the resultant of two components displaced by 90 deg. One is the resistance drop, due entirely to ohmic resistance, and the other the reactance drop, which is dependent upon the magnetic leakage between the high and low-tension windings.

Reversed Phases.

When connecting transformers star fashion, it is easy to get one of the windings reversed with respect to the other two, but this can readily be ascertained by taking voltage readings between the three phases. If one of the phases is reversed, then, instead of obtaining the correct line voltage on each of the three phases, two of the phases will have a considerably lower voltage. Great care must be taken with the mesh-connected transformers to avoid a reversed phase, for when the mesh circuit is completed, a heavy circulating current will be set up in the windings. Before the mesh circuit is closed, the primary windings should be energised, and a voltmeter should be connected across the ends of the mesh-connection that remain uncoupled. If no reading is obtained, it is safe to join these ends together, but if one of the phases happens to be reversed, the reading obtained will be equal to twice the line pressure. If the secondary winding of a transformer is wound similarly to the primary winding, two transformers working in parallel should be connected up symmetrically, but if the windings are relatively opposite, a symmetrical connection would have the effect of putting the two transformers in series with a closed connection. The fuse test previously described will readily show whether the connections are correct, but a method of finding how the primary and secondary coils are wound is to connect one of the primary leads to one of the secondary leads. If a low pressure be then applied to the high voltage winding, a voltmeter joined across the two open ends of the windings will either give a reading equivalent to the sum or difference of the primary and secondary pressures, according to the relative direction of the windings. If the reading obtained is equivalent to the sum of the two voltages, the transformer is said to be of positive polarity, but if the reading is equivalent to the difference of the voltages, it is said to be of negative polarity. When paralleling two three-phase transformers, it is, of course, necessary to ensure that there is zero voltage between the ends that are connected together. As in the case of single-phase transformers, this can be done by connecting voltmeters across the terminals that are to be joined together, the leads being reversed if necessary. By directly connecting one lead of one transformer to one lead of the other transformer, the test can be made with only one voltmeter. If the neutral points of two star-connected transformers be connected, then voltage tests between the outer ends of the two trans-

formers to be paralleled can, of course, be made without making any other connections, but if the neural points are not connected two of the outer ends belonging to the transformers must be joined together, otherwise, when the voltmeter leads are coupled up, there will be an open circuit. Different kinds of errors in the connections give various results, but these need not be discussed. Symmetrically-connected windings will give the proper results if all the transformers have the same polarity, but if the two sets have opposite polarity, there will be a phase difference of 180 deg. When applying the voltmeter test with the neutrals of the two transformers connected, the voltmeter will give a reading equivalent to twice that across a single phase. Transformers used on three-phase circuits can naturally be tested for polarity by connecting the primary and secondary windings together in the manner previously described, each transformer being tested separately with a single-phase supply.

(Concluded.)

SOME INTERESTING POINTS IN RELATION TO OIL PROSPECTING.

(Concluded from page 287.)

Land Rights.

"Now, I am not posted on the rights of those noble Lords in the hands of your country, but when I was there the Lord of the Manor had and did claim and retain some rights, although he sold or leased the land; he retained the rights to any mineral matter that lay beneath the surface of such land, as copper, iron, lead, tin and coal lands; also salt mines; these are classed as minerals and fuels. Here the Government donated to the different railroad companies who built the Continental line every odd numbered section of land for a distance of 10 miles on each side of such Pacific Railroads as they put their lines and carried passengers and freight, etc. Each section contains 640 acres; this was to be used for farming purposes and the coal for fuel purposes if found on any such land, but the Government retained the right to all minerals the land might contain for its citizens, or any foreign-born who has declared his intention; these latter have the right to locate for homesteads 160 acres for farming purposes and 320 if the land is what is known as desert land, but they must cultivate and plant so much per year; after they have done so much work they can prove up and get patent for the land by paying so much per acre, which is a small amount, and they become owners in fee simple, but the Government, like the Dukes, etc., in your country still claim the mineral rights in such lands in both agricultural and railroad land so donated.

"Now, I think that the owners of any land to be prospected for oil ought to be considerate enough not to want both the cat and skin: he, the prospector, is paying all the cost of such prospecting of said lands in your country, and besides they are taking all the chances, and besides they are going into the game blind, but are willing to pay and take a chance. You know, it costs money to buy whisky; so also to prospect ground for oil: holes are very costly, and nobody knows it better than Lord Cowdray and those who have played at the game; the owners ought to be content with a royalty, same as they do here; in a wild cat and blind territory country the same as yours they ought to be content, say, with one barrel out of every ten from each well that might be brought in, and not make a charge of ninepence per gallon, as stated.

Procedure.

"From the fact, let us suppose some good producing oil land is found (and I think you have plenty of it and I feel from experience there is plenty of it in your country, and it would be an easy trick for those who know how to find it without going after it blind, as you appear to be doing if you are drilling in coal beds as stated) and good producing wells were brought giving thousands of barrels a day, as we have them here in the past in America, and that there was more oil produced than there was demand, then the price would drop, as it did in the local fields here from 2.60 dollars per barrel to 10 cents per barrel; it would not be fair proposition that the owner of the land should demand his ninepence per gallon from the producer: the wells would be closed and the Government would suffer and other users also suffer in short order. In such a case the Government would be compelled to take over the wells by law, or cause them to start up and pay a reasonable royalty to those who own the land the wells are on: and they, the owners, could not help themselves; they would have to take what was fair.

"Another condition ought to be improved upon; the owners of the land where the oil is being prospected for oil, namely: if the party who pays the cost of such hole finds no oil on the said lease or land, but he discovers other valuable minerals, and no such minerals were ever discovered before, then in such cases the owners of such land ought to be made to pay for the cost of the said hole: providing, however, that the minerals are found in sufficient quantities to pay for developing the same: this would be of value to the country at large, for it would increase the amount of raw materials and thus save importing so much of the same.

Things to Know.

"There are a few other things that you ought to know about petroleum oil, as found in nature's laboratory, the earth. It is an accepted fact by all mineralogists, geologists, chemists and scientists, that petroleum oil owes its origin to the animal or vegetable kingdoms. I maintain that petroleum oil, as it is found in the earth, is not any one of them: I claim that petroleum oil is neither a direct product of either animal, vegetable or mineral: and I am ready to prove that is is not a direct product of any of them, if called upon: and I am willing that any and all of the above named scientists shall be the judges. But I demand that their verdict shall be based upon facts and not on suppositions.

"I would say for your information and all others who are interesed in wild catting for petroleum oil in England that we here in California produced one hundred million barrels of oil last year, and will produce more the coming year. We are like the chicken only a few days out of its shell, that we have only just begun to scratch for the oil that California contains.

"More valuable commercial commodities can be produced from it than any other oil, and I have made many of them. Now I would warn both the lords of the manor and labour not to get a swelled head when you strike oil (which you sure will), but give a square deal to each other.

"Some 20 years ago an old minister of the gospel wrote a strong protest to the Los Angeles *Times* against taking the oil out of the ground; he said the Lord wanted it to burn up the earth with and all sinners at the last day. We certainly will take his advice and leave him enough for the purpose, but we took some of it to burn up the Kaiser and his bloodthirsty gang; and it was California oil, and we still have enough."

(Concluded.)

THE UNAFLOW STEAM ENGINE.

By D. H. Yates.

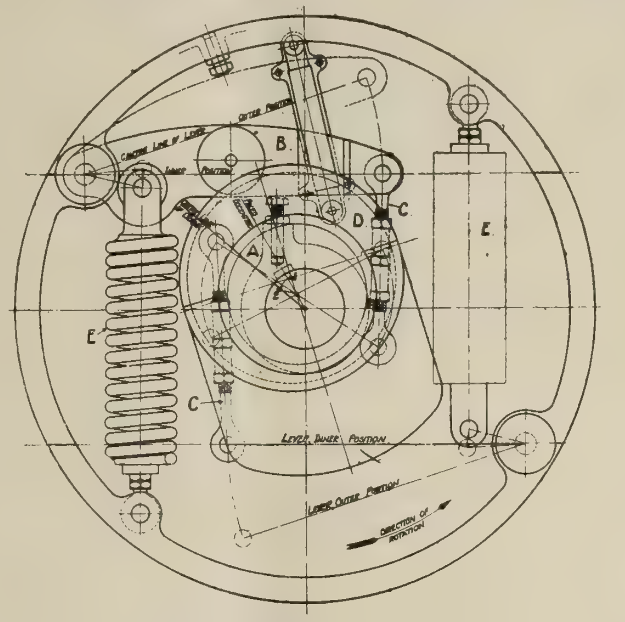
(Continued from page 269.)

Governor.

The governor is of the crankshaft type, and is shown, together with its connections to the valve gear, in Figs. 18 and 19. Fig. 18 shows the governor illustrated by means of a circle, and connected to the bottom arm of the rocking lever by means of the eccentric rod. The top arm of the rocking lever is connected through coupling rods to the cams and rollers in the bonnets, these cams in their turn operating the valves as explained previously.

Fig. 19 shows the arrangement of the governor, which is contained inside a cast-iron case. In the centre of the casing is cast an eccentric A, which is placed at a certain fixed angle of advance to the crank. Working on the top of this fixed eccentric is a movable eccentric D, the movement of which round the fixed eccentric is shown by the arc 1.2. With the governor at its "inner" and "outer" positions, the movable eccentric is at 1 and 2 respectively. The movable eccentric obtains its motion from the two governor levers B, being connected thereto by means of the links C. When the governor revolves, the governor levers B move outwards, due to centrifugal force, being regulated by the tension springs E.

The eccentric clips and rod are connected to the movable eccentric. This arrangement forms a compound eccentric with a maximum travel when starting up, thus giving a maximum travel of the cam rollers, resulting in a late cut-off in the cylinder. As the engine speeds up the movable eccentric moves round the fixed eccentric, and thus reduces the movement, and at the same time alters the angle of advance of the compound eccentric, both these results having the effect of causing an earlier cut-off, and in this manner regulating the speed of the engine.

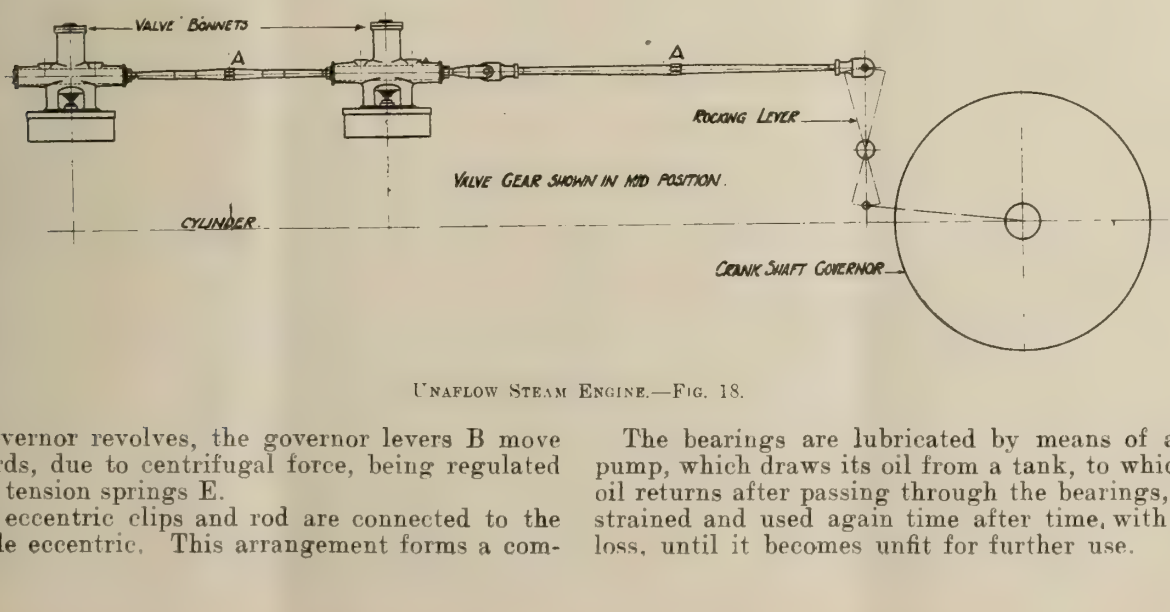


Unaflow Steam Engine.—Fig. 19.

Lubrication.

The cylinder is lubricated by means of a sight-feed pressure lubricator, one feed being led to each steam pipe, and two to the cylinder barrel.

The cylinder is flushed before starting by means of a hand pump to ensure initial lubrication. By careful adjustment and attention the amount of cylinder oil used may be reduced to a very small quantity.



Unaflow Steam Engine.—Fig. 18.

The bearings are lubricated by means of an oil pump, which draws its oil from a tank, to which the oil returns after passing through the bearings, to be strained and used again time after time, with little loss, until it becomes unfit for further use. After

leaving the pump the oil passes to the crankshaft pedestals, and thence by means of holes in the crankshaft and cranks to the crank pin. It is then led through a pipe along the connecting rod to the crosshead and slippers. The oil feed to the governor is also taken from the hole in the crankshaft, and all the oil used is drained back by means of pipes and channels to the crank chamber, and thence to the tank. The pressure indicated by the oil-pressure gauge, which is attached to the system near the pump, is about 20 lbs. per square inch, and this pressure gives a very efficient lubrication.

The valve gear pins are lubricated either by grease or oil, as may be most convenient, whilst the air pump gear is lubricated by means of sight-feed drop lubricators and wipers.

Speed Fluctuations.

The speed fluctuations of an engine may be classified as follows:—

(1) Speed variation due to changes of load;

(2) Speed variation within one working cycle.

Of the above, (1) is controlled by the governor, and amongst the various types of reciprocating engines the Unaflow follows load variations quicker than multiple-expansion engines, due to the fact that the steam supply is regulated in and passes through one cylinder, as compared with two or more cylinders in the case of multiple-expansion engines, through which the steam has to pass before the full effect of the governor is obtained.

The following figures are based on governors with similar characteristics and a permanent speed variation of 5 per cent between full load and no load:—

	Unaflow Engine	Compound Engine.	Triple Expansion Engine.
25% Load Variation.			
(*a*) Permanent Speed Variation ..	2%	2%	2%
(*b*) Momentary Speed Variation .	3%	3½%	4%
(*c*) Time in seconds for settling down to permanent speed ..	4	6	10
50% Load Variation.			
(*a*) Permanent Speed Variation ..	3%	3%	3%
(*b*) Momentary Speed Variation .	4½%	5%	6%
(*c*) Time in seconds for settling down to permanent speed ..	6	10	20
100% Load Variation.			
(*a*) Permanent Speed Variation ..	5%	5%	5%
(*b*) Momentary Speed Variation .	7%	8%	10%
(*c*) Time in seconds for settling down to permanent speed ..	8	15	30

As regards (2), this is caused by the periodical fluctuation of energy during each working stroke, and is defined by the term "coefficient of speed fluctuation," which equals—

$$\frac{\text{Maximum speed} - \text{minimum speed}}{\text{Mean speed.}}$$

It is also sometimes denoted by the term "cyclic irregularity," and is often symbolised by the letter X. It is controlled by the flywheel, and depends on the purpose for which the engine is used, being kept within certain limits for different classes of work, *e.g.*, for alternating-current work X must be 1/250 to 1/300, whilst for direct-current work X must be 1/100 to 1/125.

(To be continued.)

SITUATION OF THE GERMAN ELECTRICAL INDUSTRY.

At the last general meeting of the Siemens-Schuckertwerke the president, Karl Friedrich von Siemens, stated that it was necessary that the works should be re-adapted as soon as possible so as to deal with peace requirements. This, however, is rendered very difficult by the lack of goodwill on the part of the workers and by the scarcity of raw materials. On the other hand, orders no longer arrive from the home market, whilst foreign countries are cancelling all their indents, as, owing to the troubled state of the country, they have no confidence in the possibility of deliveries. Due also to the steady demand for increased wages, it is also impossible to fix any definite sale prices, and, despite the higher wages paid, the firm's output is steadily declining owing to strikes, political demonstrations, workmen's meetings, and other interruptions to work. Finally, the occupation of the left bank of the Rhine renders it impossible to obtain a large number of semi-finished separate parts of which the firm is urgently in need. At a recent general meeting of the Elektrizitaets S.G., of Nuremberg, the president stated that the year 1917-18 had been fairly favourable, but, at the present time, the situation is so bad that the near future affords food for serious anxiety. The severe armistice terms have paralysed industry, and the political and economic situation of the country is gloomy in the extreme. As a matter of fact, in most Nuremberg works the hours of work had been cut down to 34 per week owing to lack of coal, cancelling of military orders, and also of many peace-time contracts. Finally, the strikes and disturbances at Berlin and many other centres have reduced the output of the mines by more than two-thirds, whilst wages and the cost of raw materials have advanced enormously. Hopes of regaining former export markets are also gradually fading away. Well, Brother Hun, such is the penalty of swelled head and making wars; as it is, it is for us and our Allies to profit by this situation to the utmost. England is insisting that all orders, both Government and private, should in future go to English firms; France is going to do the same wherever possible, and where not possible orders will be placed with Allied firms, but all contracts, dealings, or communications with enemy firms, or with firms directly or indirectly associated therewith, is strictly "taboo." That is the right spirit, and we only hope that it will be put into actual practice. The best way to punish the Hun is through his pocket.

DIESEL ENGINE USERS' ASSOCIATION.

APRIL MEETING.

The announcement was made at the last meeting of the Diesel Engine Users' Association that the Committee had further considered the question of endeavouring to obtain better terms from the Inland Revenue Authorities in regard to the allowance made for depreciation of Diesel and semi-Diesel engines in connection with income tax assessment. The constitution of a special committee to deal further with the matter was approved. The Association has already been instrumental in obtaining somewhat

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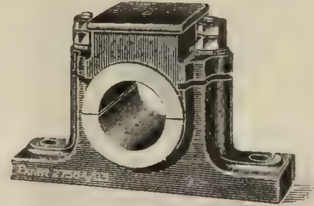

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0	..	1 1 0	2 2 0	3 3 0	5 0 0	6 1 0	7 2 0	8 3 0	10 0 0	11 1 0	0
1	0 0 14	1 1 14	2 2 14	3 3 14	5 0 14	6 1 14	7 2 14	8 3 14	10 0 14	11 1 14	1
2	0 1 0	1 2 0	2 3 0	4 0 0	5 1 0	6 2 0	7 3 0	9 0 0	10 1 0	11 2 0	2
3	0 1 14	1 2 14	2 3 14	4 0 14	5 1 14	6 2 14	7 3 14	9 0 14	10 1 14	11 2 14	3
4	0 2 0	1 3 0	3 0 0	4 1 0	5 2 0	6 3 0	8 0 0	9 1 0	10 2 0	11 3 0	4
5	0 2 14	1 3 14	3 0 14	4 1 14	5 2 14	6 3 14	8 0 14	9 1 14	10 2 14	11 3 14	5
6	0 3 0	2 0 0	3 1 0	4 2 0	5 3 0	7 0 0	8 1 0	9 2 0	10 3 0	12 0 0	6
7	0 3 14	2 0 14	3 1 14	4 2 14	5 3 14	7 0 14	8 1 14	9 2 14	10 3 14	12 0 14	7
8	1 0 0	2 1 0	3 2 0	4 3 0	6 0 0	7 1 0	8 2 0	9 3 0	11 0 0	12 1 0	8
9	1 0 14	2 1 14	3 2 14	4 3 14	6 0 14	7 1 14	8 2 14	9 3 14	11 0 14	12 1 14	9

Weight of Beam, advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight.	lbs. 1·16	lbs. 2·33	lbs. 3·50	lbs. 4·66	lbs. 5·83	lbs. 7·0	lbs. 8·16	lbs. 9·33	lbs. 10·50	lbs. 11·67	lbs. 12·83	lbs. 14	Weight.

Weights of Lengths of Rolled Steel Sections.

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Ft.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	0 12 2 0	1 5 0 0	1 17 2 0	2 10 0 0	3 2 2 0	3 15 0 0	4 7 2 0	5 0 0 0	5 12 2 0	0
10	1 1 0	0 13 3 0	1 6 1 0	1 18 3 0	2 11 1 0	3 3 3 0	3 16 1 0	4 8 3 0	5 1 1 0	5 13 3 0	10
20	2 2 0	0 15 0 0	1 7 2 0	2 0 0 0	2 12 2 0	3 5 0 0	3 17 2 0	4 10 0 0	5 2 2 0	5 15 0 0	20
30	3 3 0	0 16 1 0	1 8 3 0	2 1 1 0	2 13 3 0	3 6 1 0	3 18 3 0	4 11 1 0	5 3 3 0	5 16 1 0	30
40	5 0 0	0 17 2 0	1 10 0 0	2 2 2 0	2 15 0 0	3 7 2 0	4 0 0 0	4 12 2 0	5 5 0 0	5 17 2 0	40
50	6 1 0	0 18 3 0	1 11 1 0	2 3 3 0	2 16 1 0	3 8 3 0	4 1 1 0	4 13 3 0	5 6 1 0	5 18 3 0	50
60	7 2 0	1 0 0 0	1 12 2 0	2 5 0 0	2 17 2 0	3 10 0 0	4 2 2 0	4 15 0 0	5 7 2 0	6 0 0 0	60
70	8 3 0	1 1 1 0	1 13 3 0	2 6 1 0	2 18 3 0	3 11 1 0	4 3 3 0	4 16 1 0	5 8 3 0	6 1 1 0	70
80	10 0 0	1 2 2 0	1 15 0 0	2 7 2 0	3 0 0 0	3 12 2 0	4 5 0 0	4 17 2 0	5 10 0 0	6 2 2 0	80
90	11 1 0	1 3 3 0	1 16 1 0	2 8 3 0	3 1 1 0	3 13 3 0	4 6 1 0	4 18 3 0	5 11 1 0	6 3 3 0	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs 6 5 0 0	t. c. q. lbs. 12 10 0 0	t. c. q. lbs. 18 15 0 0	t. c. q. lbs. 25 0 0 0	t. c. q. lbs. 31 5 0 0	t. c. q. lbs. 37 10 0 0	t. c. q. lbs. 43 15 0 0	t. c. q. lbs. 50 0 0 0	t. c. q. lbs. 56 5 0 0	t. c. q. lbs. 62 10 0 0	Weight.

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Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	Ft.
0	..	1 1 0	2 2 20	4 0 2	5 1 12	6 2 22	8 0 4	9 1 14	10 2 24	12 0 6	0
1	0 0 15	1 1 25	2 3 7	4 0 17	5 1 27	6 3 9	8 0 19	9 2 1	10 3 11	12 0 21	1
2	0 1 2	1 2 12	2 3 22	4 1 4	5 2 14	6 3 24	8 1 6	9 2 16	10 3 26	12 1 8	2
3	0 1 17	1 2 27	3 0 9	4 1 19	5 3 1	7 0 11	8 1 21	9 3 3	11 0 13	12 1 23	3
4	0 2 4	1 3 14	3 0 24	4 2 6	5 3 16	7 0 26	8 2 8	9 3 18	11 1 0	12 2 10	4
5	0 2 19	2 0 1	3 1 11	4 2 21	6 0 3	7 1 13	8 2 23	10 0 5	11 1 15	12 2 25	5
6	0 3 6	2 0 16	3 1 26	4 3 8	6 0 18	7 2 0	8 3 10	10 0 20	11 2 2	12 3 12	6
7	0 3 21	2 1 3	3 2 13	4 3 23	6 1 5	7 2 15	8 3 25	10 1 7	11 2 17	12 3 27	7
8	1 0 8	2 1 18	3 3 0	5 0 10	6 1 20	7 3 2	9 0 12	10 1 22	11 3 4	13 0 14	8
9	1 0 23	2 2 5	3 3 15	5 0 25	6 2 7	7 3 17	9 0 27	10 2 9	11 3 19	13 1 1	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	0 1·25	0 2·5	0 3·75	0 5·0	0 6·25	0 7·5	0 8·75	0 10	0 11·25	0 12·5	0 13·75	0 15	

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Ft	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	0 13 1 16	1 6 3 4	2 0 0 20	2 13 2 8	3 6 3 24	4 0 1 12	4 13 3 0	5 7 0 16	6 0 2 4	0
10	1 1 10	0 14 2 26	1 8 0 14	2 1 2 2	2 14 3 18	3 8 1 6	4 1 2 22	4 15 0 10	5 8 1 26	6 1 3 14	10
20	2 2 20	0 16 0 8	1 9 1 24	2 2 3 12	2 16 1 0	3 9 2 16	4 3 0 4	4 16 1 20	5 9 3 8	6 3 0 24	20
30	4 0 2	0 17 1 18	1 10 3 6	2 4 0 22	2 17 2 10	3 10 3 26	4 4 1 14	4 17 3 2	5 11 0 18	6 4 2 6	30
40	5 1 12	0 18 3 0	1 12 0 16	2 5 2 4	2 18 3 20	3 12 1 8	4 5 2 24	4 19 0 12	5 12 2 0	6 5 3 16	40
50	6 2 22	1 0 0 10	1 13 1 26	2 6 3 14	3 0 1 2	3 13 2 18	4 7 0 6	5 0 1 22	5 13 3 10	6 7 0 26	50
60	8 0 4	1 1 1 20	1 14 3 8	2 8 0 24	3 1 2 12	3 15 0 0	4 8 1 16	5 1 3 4	5 15 0 20	6 8 2 8	60
70	9 1 14	1 2 3 2	1 16 0 18	2 9 2 6	3 2 3 22	3 16 1 10	4 9 2 26	5 3 0 14	5 16 2 2	6 9 3 18	70
80	10 2 24	1 4 0 12	1 17 2 0	2 10 3 16	3 4 1 4	3 17 2 20	4 11 0 8	5 4 1 24	5 17 3 12	6 11 1 0	80
90	12 0 6	1 5 1 22	1 18 3 10	2 12 0 26	3 5 2 14	3 19 0 2	4 12 1 18	5 5 3 6	5 19 0 22	6 12 2 10	90

Ft	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	6 13 3 20	13 7 3 12	20 1 3 4	26 15 2 24	33 9 2 16	40 3 2 8	46 17 2 0	53 11 1 20	60 5 1 12	66 19 1 4	

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THE METROPOLITAN WATER BOARD require the services of three CIVIL ENGINEERING DRAUGHTSMEN, accustomed to the Preparation of Drawings customary in a Waterworks undertaking; also two MECHANICAL ENGINEERING DRAUGHTSMEN, experienced in the design of Steam Power Plants and Pumping Machinery.

The appointments are of a temporary character, and will be held during the pleasure of the Board, at an inclusive salary of £225 per annum.

Applications, with particulars of training and experience, are to be sent to the Clerk of the Metropolitan Water Board, 2, South Place, Finsbury, E.C. 2, endorsed "Civil Engineering Draughtsmen" or "Mechanical Draughtsmen."

WANTED, JUNIOR DRAUGHTSMAN; some experience in internal-combustion engines desired.—Apply R. A. Lister and Co. Ltd., Engine Department, Dursley.

ENGINEERS, DRAUGHTSMEN, &c.

WANTED, a Young CIVIL ENGINEER of good address (Public School man preferred) who has experience in roadmaking as well as some knowledge of mechanics and internal-combustion engines, to represent and travel on behalf of Messrs. Barford and Perkins Ltd., Motor Roller Works, Peterborough.

DRAUGHTSMAN for General Engineering Work required.—Apply, stating age, experience and salary, to Abram Lyle and Sons Ltd., Plaistow Wharf, Victoria Docks, London, E 16.

DRAUGHTSMAN, having all-round practical experience in Fan Work, capable correspondent.—Apply in confidence, Managing Director, Standard Engineering Co. Ltd., Leicester.

ENGINEER, reliable, wanted immediately, to take charge of engines and steam-raising plant; applicants must state age, experience and wage required.—Apply W. S. Mallalieu, Jackson and Steeple Ltd., Riverside Mills, Stalybridge.

DRAUGHTSMAN and Junior; experienced ventilating, warming, humidifying. DRAUGHTSMAN, experienced in the design of air compresors, pumps, fans, etc.; state full details.—Address H. Smethurst and Son Ltd., Engineers, Hollinwood.

WANTED, immediately, highly-skilled TURNERS for heavy, medium, and light work; highly-skilled MARKER-OUT for good-class work; highly-skilled JIG and GAUGE MAKER.—Apply giving full particulars, experience, age, etc., the Brush Electrical Engineering Co., Loughborough.

DRAUGHTSMAN required for motor design, to draw out mechanical details of electrical motors. Good experience necessary. Should be able to make own calculations of strength of parts, bending moments and deflections of shafts, etc.—State age, experience and salary required to Harland and Wolff Ltd., Belfast.

TRADE ITEMS, NOTES, &c.

A Swedish Government Commission has been investigating the use of iron and zinc as electrical conductors. Cables were made with a centre wire of zinc and the outside wires alternately of zinc and iron, the proportion of zinc to iron being 4 to 3. These cables were made with 19 strands, 10 of zinc and 15 of iron; but larger sizes with 37 strands in all have been made. The cables apparently possessed promising qualities for high voltage transmission. The conductivity is about one-fourth that attainable with poor copper. A copper conductor in these circumstances could be replaced by a zinc-iron cable, having about four times the cross-section and 3.3 times the weight.

THE GERMAN IRON MARKET.—The continued brisk demand for all kinds of iron and ironware cannot be satisfied, as production is still very limited. In fact, the output is less than in the previous month (March), owing to strikes, scarcity of coal, and transport difficulties. Months are being asked for the delivery of even such simple sorts as rolled iron, whilst, within the past few weeks, a wild juggling in prices has been going on in connection with iron in middlemen's hands. The official Union prices are practically disregarded, and lines in special request (such as bars and plates) are now fetching in the open market Mk. 100 more than the rates fixed by the unions; since the abolition of the maximum prices there has been absolutely no more control at all, and it is doubtful whether the steady advance in prices will cease. The coal syndicates are also urging a sharp advance in prices, and the pig-iron union has already notified that prices will shortly be again increased. All this will, of course, lead to an advance in prices in all other products. As a matter of fact, prices are now in a worse state than during the first year of war, as then the Government intervened, but now the market is quite free. In most works, the productive capacity is now scarcely 10 per cent, in spite of still unexecuted orders, and the desire to work to stock in view of the hoped-for prompt revival in export trade when peace has been signed. Blast-furnaces are also compelled, by shortage of coal, to greatly reduce their activity, so that the shortage of pig-iron is growing acuter daily.

The Highways Committee of the Bedfordshire County Council has considered an application from the Osram-Robertson Lamp Co. Ltd., for permission to construct a level crossing on the Leagrave Marsh and Luton Main Road, in the parish of Limbury. It appears that the Company propose to acquire land adjoining this road for the purpose of erecting large works employing many thousands of hands, and they require a level crossing in order to connect their works with the line of the Midland Railway. The Committee reported in favour of sanctioning the level crossing.

The paper driving-belts to which German workshops have resorted are made by weaving or braiding thread spun from paper cut into narrow strips. Of the two kinds of this belting supplied, the one usually preferred is prepared by cutting the paper fabric into bands 40 to 50 yards long and using these to build up the required width and thickness. A strengthening core may be cotton or sheet metal, though paper thread and metal wire interwoven seems to have given the most satisfactory results. The paper fabric surrounds the core, and the whole is sewn with strong thread. The woven-paper belts are flexible and durable, and a tensile strength of 600 to 800 pounds per inch of width.

In discussing the most economical size of unit for steam turbines, *Power* says that with the growth of large power systems supplied by a few huge stations operating in parallel, costs would be seriously affected if units of 30,000 kilowatts or under were selected. Such a limit might be best for some stations or some systems. The factors that will fix ultimate capacity are the physical limits, shop practice, and shipping restrictions. Capacities have now reached 70,000 kilowatts in one unit—the compound machine in the Seventy-Fourth Street station of the Interborough Rapid Transit Co. If the load conditions warranted, no doubt the purchasers would have called for 100,000 kilowatt machine.

better terms for users of Diesel engines, although the Inland Revenue Authorities have not agreed to the full amount of the allowance which the Association claims to be fair and reasonable. The position of users of semi-Diesel engines in the matter at the present time is very satisfactory, and now that the Association has extended its membership to users of those engines it is hoped that its influence may be brought to bear on the Inland Revenue Authorities to grant some relief to the users of the semi-Diesel type of engine. Those interested in this matter are therefore invited to communicate with the Honorary Secretary of the Diesel Users' Association, at 19, Cadogan Gardens, London, S.W.3.

Reference was made to the recent visit to London of the Vice-President of the new French Association of Manufacturers and Users of Internal-combustion Engines, and a suggestion that the two Associations be affiliated was cordially approved.

Mr. H. S. Brackenbury gave a report of an explosion which had occurred on a Diesel engine at Wealdstone, and which fortunately had not resulted in any personal injury. An interesting discussion followed. It was decided that the matter should be discussed further at the following meeting of the Association, when the breakdown of a Diesel engine at Weymouth is also to be reported by Mr. G. W. F. Horner and discussed. It is probable that the discussion of these two matters may be the means of circulating information of general interest among Diesel engine users, and it is proposed in due course to publish a report of these discussions.

MOTORCYCLE DESIGN.

By D. S. Heather, B.Sc.

(Continued from page 274.)

Engines.

There has been little or no progress in the main essentials of engine design for the past six or seven years, the single-cylinder two-stroke, and the small horizontally opposed twin four-stroke engines having established themselves firmly in the cheap lightweight classes and the 350c.c. solo classes respectively. That there have been improvements in detail is, of course, an undoubted fact, but generally speaking, the average single-cylinder or Vee-twin engine of to-day possesses exactly the same features as similar engines of seven, or even ten years ago. If the general design of these engines was entirely satisfactory, there would be no harm in this apparent stagnation, but the author believes that any unbiassed investigator will agree that there is much room for radical improvement.

As an example, take the typical built-up crankshaft construction which has been used in motorcycle engines since the very earliest days of the industry. This is not a cheap production job, involving as it does, the manufacture of five separate parts, namely, two flywheels, a crankpin, and two short main shafts. Accurate hand fitting, in conjunction with a special trueing jig, is necessary for its erection, and even then it cannot be guaranteed to remain in truth for long. Big end bearings are restricted, both in diameter and length, by the proximity of the flywheel rims, and consequently a plain bearing of reasonable dimensions, which would ensure satisfactory length of service, cannot be arranged. Most designers have therefore been forced into the adoption of a roller bearing for the big end, which certainly cannot be considered ideal for use under the rapidly fluctuating loads which are imposed on the bearing. To fit a new big end bearing necessitates the dismantling of the crankshaft assembly, and the plight of the owner or small garage man who has to re-erect the job without a special jig, can be better imagined than described. Manufacturers often instruct riders of their machines to return the complete crankshaft and connecting rod assembly to them if replacement of the big end bearing is necessary, but this is frequently neither convenient nor possible. Consequently a large number of engines of this type are to be found running with crankshafts permanently out of alinement. In addition to this, the flywheel diameter is restricted by the possible crankcase diameter, so that small diameter heavy flywheels have to be employed. Then, too, as the flywheels are spinning at high speed in close proximity to the crankcase walls, a very considerable loss of power at high rates of revolution results, while the centrifugal action tends to throw oil away from the big end bearing and starve it of oil, unless a drilled crankshaft is used. A built-up type of crankshaft is never employed in other types of prime movers if a one-piece crankshaft can be used, and since the small two-stroke and the horizontally-opposed twin engines have proved the practicability of the solid crankshaft for motorcycle use, it is strange that it has not been generally adopted in place of the conventional built-up type. The solid crankshaft would be cheaper to manufacture, more satisfactory and durable in use, and would permit the use of a light large diameter outside flywheel, and a split big end bearing of reasonable dimensions.

Connecting rods call for no comment, but many motorcycle pistons are excessively heavy and subject to serious distortion, mainly through incorrect design of the ribs. No doubt there will be improvement in this direction as a result of experience with pistons for air-cooled aero engines, and it is to be hoped that designers will carefully consider the method to be adopted for locating the gudgeon pin. The old method of using a taper gudgeon pin is not at all satisfactory, since in any but the most highly skilled hands removal or replacement of the pin inevitably causes distortion of the piston. The rectification of such distortion cannot be carried out properly without regrinding the piston, and since this is not a job which can be done outside the manufacturers' works, any system of locating the pin which tends to cause distortion should be scrapped. A perfectly satisfactory job can be made by fixing the pin in the rod and bushing the piston, or by allowing the pin to float both in the rod and the piston, suitable means being provided for preventing endwise motion of the pin and consequent scoring of the cylinder walls.

The conventional motorcycle timing gear is also far from perfect. The necessity of cramming the whole of the gear into a space of about 1 in. wide makes it impossible to provide cams, wheels, rockers, or bearings of sufficient width to ensure durability. The timing wheels and cams are usually carried by small plain bushes at each end of the spindles, the

inner bush being carried in the crankcase wall, and the outer bush in the timing case cover. This latter is usually fixed to the crankcase by a number of small setscrews, without any proper means of location, and consequently, if the cover is removed for any reason, it is impossible to guarantee that it is replaced in the correct position to ensure that the bushes at the opposite ends of the timing wheel spindles are accurately aligned. There are one or two designs which avoid this trouble to some extent by the use of a circular timing case cover which is properly spigoted into the crankcase, but this is unusual. The bearings, too, do not usually exceed 10 mm. diameter by 10 mm. long, which does not provide nearly sufficient bearing area considering the high speeds attained by motorcycle engines, and the stiff valve springs employed, and consequently, not only do the bearings themselves wear badly, but they frequently hammer loose in the aluminium case in which they are carried, w subsequent trouble. The restriction of space also makes it necessary to cut down the diameter of the tappets and guides much below what is desirable if reasonable wearing qualities are to be obtained, and as a result tappets quickly wear loose in their guides. Proper arrangements for preventing oil leakage cannot be made with these small diameter tappets, and so they soon begin to act as little oil pumps, distributing oil all over the outside of the engine, at quite an alarming rate. It is only necessary to compare the bearing surfaces, the width of cams, and the diameter of tappets provided for an 85 mm. bore motorcycle engine with those provided on an 80 mm. bore car engine in order to appreciate the reason for the poor durability of the timing gear of the average motorcycle compared with that of the timing gear of a car is partly due to the before-mentioned troubles, and partly to the frequent use of a multiplicity of timing wheels, cams, and roller ended rocker levers and tappets. A timing gear with only one pair of timing wheels, cams of good width, no rockers, and large diameter mushroom-headed tappets would be as silent as that of a first-class car, but it cannot be provided unless the conventional arrangement is done away with and replaced by a more rational layout.

The methods usually adopted for driving the magneto are also open to severe criticism. If a chain drive is used, the usual result is to make the timing gear decidedly inaccessible. The chain itself is usually well up to its work, but the clearances allowed in the chain case are much too small, with the result that after a thousand miles or so of running the chain is touching the case both at the sides and the bottom, particularly where the tight or driving side of the chain is on the top, as is the case where the magneto is carried in the conventional position in front of the engine. The means provided for adjusting the position of the magneto are so crude that it is a very difficult matter to get the chain tension correct, with the result that the chain is either set so tight that rollers break, or it is left so slack as to wear out the case. It is certainly time that a better means of holding down the magneto was adopted; it is not satisfactory to anchor it by means of four hexagon headed setscrews passing through clearance slots in the bracket. Apart from the fact that two of the setscrews are invariably inaccessible, the design does not by any means ensure that the magneto is in alignment, and the bad results of faulty alignment are not confined to the rapid wear of the chain, but include excessive wear of the small ball bearings on which the magneto armature is carried. Where a gear drive is used for the magneto, the position is little better, for although adjustment of the magneto position is neither necessary nor desirable, the system usually involves a multiplicity of small, high speed gear wheels, inadequately supported on small bearings, so that excessive wear soon develops, with accompanying noise. If a chain drive is used, some proper provision for lubrication of the chain should be made, as it is not satisfactory to rely on leakage of oil from the timing gear case through the chain wheel spindle bearing.

Among other engine details which require attention is the provision of some proper means of locating the crankshaft endwise in the crankcase, as distinct from the present method of allowing the flywheel bosses to rub against the crankcase sides or the outer races of the main ball bearings. There is also room for improvement in the method of holding the small timing wheel to the crankshaft, neither the split shaft nor the screw-on method being satisfactory, since both these methods cause trouble if the job has to be dismantled outside the maker's works. The conventional cotter and slot method of holding the valve spring collars in place should be abandoned entirely, as cotters burr up and become difficult to remove, apart from the fact that the cotter slots seriously weaken the valve stems and are a frequent source of broken valves. The valve spring collars themselves should be more carefully designed, and more accurately machined, so that the collar cannot tip over and hammer its way into the valve stem so much that a file has to be used, under most awward conditions, before a valve can be removed. Proper provision should also be made for preventing oil leaks through the pulley side cranshaft main bearing. A felt washer at this point is no use at all, as it quickly becomes soaked with oil, and altogether loses its effectiveness. It should be a simple matter to provide either proper thrower discs, or better still, a reverse thread, which would entirely prevent oil leaks.

(To be continued.)

ECONOMIES IN THE GENERATION AND USE OF STEAM.

By Sidney F. Walker, R.N., M.I.E.E., M.I.M.E.

(Continued from page 229.)

Nearly all the rotary air pumps work with a closed water circuit. In the Le Blanc there is a centrifugal pump, described as a reversed Pelton turbine wheel, running inside a closed chamber, which is filled with water, and communicating with a tank, also containing a certain quantity of water. When the pump is running, centrifugal force causes a lowered pressure in the casing of the pump, and this causes a flow of water from the tank through the casing. The exhaust port of the engine or turbine opens to the casing of the pump, and the result is similar to that of the flowing water in the ejector condenser. The water flowing round the casing of

the pump draws in air and uncondensable vapours from the condenser, and the small slices of water into which the circulating water is broken up entrain a small quantity of air and gases, which are carried off into the diffuser tube leading from the pump. The water with the air and gases is carried into the tank, where they are gradually separated. With the Le Blanc system, a separate centrifugal pump is usually employed to carry off the condensate, the two pumps being driven by an electric motor or a small steam turbine, the axles of the three units being connected.

Other forms of the rotary air pump have been designed by the Rees-Roturbo Co. and others. One that was very highly spoken of before the war was designed and made by the A.E.G. Co. Another development of the ejector is known as the "Kinetic" system. In this system a steam jet is employed in series with an ejector. The steam jet acts in a very similar manner to that introduced by Sir Charles Parsons. It draws the air and gases from the outlet of the condenser, and delivers them to the ejector, from which they are delivered into a tank. The condensate is carried off by what is practically a compound pump, and the cooling water for the ejector is circulated around a closed circuit.

In another form of ejector, the invention, the writer understands, of a German, adopted in this country by Messrs. Willans and Robinson, the circulating water is made, either partially or wholly, to pass through an ejector, which is employed to draw off the air and gases. A centrifugal pump is used for the circulating water, and another to draw off the condensate.

A very interesting apparatus is made by the Worthington Pump Co., called by them a hydraulic vacuum pump. This works in connection with a tank from which the circulating water is obtained, and to which it returns. There is a centrifugal pump delivering water from the tank to an annular nozzle, which is practically the nozzle of an ejector condenser. The water, after passing through the nozzle, flows over what is called a jet transforming wheel. This is a small revolving wheel running on a vertical spindle in ball bearings. The water, issuing from the nozzles above, impinges on the revolving wheel, and is broken up into a number of small jets, which are also given a whirling motion. The air and gases from the condenser enter the apparatus opposite the revolving wheel, and are entrained by the small jets in a manner similar to the Le Blanc wheel, and the ordinary ejector. The water, with the air and gases it has absorbed, is carried down through a diffuser tube into the tank below, from which it recommences its circuit through the pump and the nozzle.

It is stated by rivals of the Le Blanc apparatus that the circulating water, being in a closed circuit, gradually rises in temperature. To avoid this, in the Worthington apparatus, a small quantity of cold water is allowed to flow into the tank to keep the temperature down, and the overflow is taken to the boiler feed.

A little consideration will show that the heating of the cooling water in the Le Blanc apparatus was to be expected. It will be remembered that a certain quantity of steam comes from the condenser with the air and gases, and its latent heat will be given up to the cooling water. In addition, some of the air and other gases will be dissolved in the water, and their latent heat will go to raise its temperature.

Another exceedingly interesting development is the dual air pump that has been introduced by Messrs. G. and J. Weir. In this apparatus, as the name implies, there are two pumps, one to extract the condensate in the usual way, and the other to extract the air and gases. Both the condensate and the air are taken from the same port in the condenser and from the same pipe, but a branch pipe is led from the main pipe leading from the condenser to the condensate pump, just after the pipe leaves the condenser, this branch pipe being connected to the suction of the dry pump. The connection between the condenser and the dry pump is so arranged that all the condensate passes to the wet pump. The dry pump has a small quantity of injection water drawn first from the hot well of the wet pump, and afterwards cooled by being forced through a special cooling apparatus, similar to some of those employed as condensers in cold storage plant. The cooler consists of a number of pairs of pipes arranged concentrically, the injection water for the dry pump flowing through the inner pipe, and cooling water flowing through the annular space between the pipes. The effect is, the water in the dry pump is kept at a comparatively low temperature, as it is being constantly circulated through the cooler, and it therefore absorbs a larger proportion of air and gases than it otherwise would do the result being the provision of a comparatively high vacuum at a low cost. The condensed vapour and air are delivered to the wet pump and are carried off with it.

(*To be continued.*)

DESIGN AND MECHANICAL EQUIPMENT OF OVERHEAD CRANES.

By H. Thornton.

(*Concluded from page 276.*)

Runner Wheels and Axles.

The crab runner wheels are usually made of cast steel, but for small cranes, say, up to 7 or 8 tons, they may be made of cast iron. They should be made as large in diameter as possible and the axles as small as possible in order to reduce the tractive resistance, and thereby reducing the current consumption. Revolving axles are usually used in this country, but on the Continent and in America fixed axles are the rule, with bushed runner wheels. English engineers generally discourage this method, but there is more prejudice and faddiness about it than anything. The fixed axle method can be relied upon, providing the bearing pressures are kept fairly low, say, under 800 lbs. per square inch, and the lubricating arrangements are satisfactory. Six tons per square inch may be allowed where the axle passes through the frame.

Cross-Traverse Gear and Motors.

The crab cross-traverse gear is usually arranged in two reductions from the motor to the axle. The brake horse power of the cross-traverse motor is calculated in a similar manner to the longitudinal travelling motor, leaving out, of course, the weight

of the bridge and substituting a tractive effort of about 60 lbs. per ton and 80 per cent mechanical efficiency of the gearing.

The brake horse power of the hoisting motor is determined in the following manner:—

$$\frac{2240\ WV}{33000\ E}$$

where W = load in tons,
V = hoisting speed in feet per minute,
E = mechanical efficiency of the mechanism.

In the majority of cases the mechanical efficiency is about 68 per cent for the main and auxiliary hoisting gears of normal cranes, therefore E = .68.

The quickest way of finding the brake horse power is $\frac{WV}{10}$, which comes to the same thing.

Strength of Gearing.

The strength of the gearing is calculated usually by the "Lewis" formula, which can be found in nearly every text-book. The pressure on the first reduction teeth is found thus:—

$$\frac{\text{Horse-power} \times 33000 \times 12}{\text{Revs. p. m.} \times \pi \times \text{diam. of pinion in inches}} \text{ load in lbs.}$$

and the speed of the pinion at the pitch line in feet per minute

$$\frac{\text{Revs. p. m.} \times \text{diam. of pinion in inches} \times \pi.}{12}$$

After finding the load on the teeth of the first reduction, the *torque* on the second motion in pound-inch units = *load found* × *radius of first wheel*, and the load on the teeth of the second motion pinion and wheel

$$\frac{\text{Torque found}}{\text{radius of second pinion,}}$$

and so on. The wheel will decide the width of face in all cases.

Hoisting Barrel.

The hoisting barrel is usually made of cast iron, and cast blank where the wire ropes go, the grooves being turned in a lathe to suit the rope diameter. The diameter of the barrel is made from 21 to 24 times the diameter of the rope, and the pitch of the grooves is usually $1\frac{1}{8}$ × diameter of rope, or slightly more, to allow for the fact that the ropes flatten out slightly when under load. If there is not sufficient side clearance, the ropes grind against each other, and are likely to break some of the strands.

Lifting Ropes.

The lifting ropes generally have a factor of safety of *seven* or *eight* in ordinary cranes and *ten* in steel-works cranes, which allows a good margin of strength even after a few strands have broken. The life of the rope depends to a great extent on the size of the barrel and pulleys around which it has to pass. The ropes used are of the quality known as "specially flexible improved plough steel," and the *number of falls* of rope are generally *four* up to 20 tons capacity, *six* falls from 20 to 50 tons, *eight* falls from 50 to 80 tons, and *twelve* falls from 80 to 120 tons and over, these varying with different makers. The advantages of a large number of falls of rope are: (*a*) As there are only two parts of rope on the barrel, it follows that the load on the barrel is only a small proportion of the whole, and consequently the load on the gearing is reduced. (*b*) Simplification of the train of gears. (*c*) A smaller rope is required which allows of proportionately larger pulleys and barrel, thus ensuring a long rope life.

Shaft Diameters.

The shaft diameters are determined from the combined bending and twisting moments which equal the "equivalent twisting moment," and the formula for this is:—

$$E = B + \sqrt{T^2 + B^2},$$

where E = equivalent twisting moment,
B = bending moment,
T = twisting moment.

Strength of Axles.

The axles are treated as beams, and the worst conditions of loading are assumed. The bending moment at any section can be determined either graphically or by calculation. The graphical method is, in some respects, the better of the two, especially in heavy cranes, as then we have a picture of the forces acting at every point of the axle, and can, therefore, design it accordingly. As the stress alternates from a positive maximum to a negative maximum, once each revolution, the working stress can be determined from Prof. Lilly's formula.

Brakes.—Brakes for electric cranes are of three types: (1) Rheostatic brakes; (2) magnetically-released brakes; and (3) mechanical brakes.

Rheostatic Brakes.

Rheostatic braking is purely electrical, and depends for its action upon the fact that if mechanical energy is expended on the motor it will generate current under certain conditions. The current must always flow through the field windings in the same direction, whether the machine runs as a generator or motor. If this condition is not fulfilled, the residual magnetism of the field will be destroyed and the polarity reversed. The load depending from the hook acts as a driving force, when the gearing is released, causing the armature to rotate. The motor then works as a generator after the connections have been altered in the controller in a suitable way, thereby converting into heat the energy of the load and acting as a brake. For this purpose the motor must be short-circuited by means of resistances in which the electrical energy produced by the motor working as a generator is transformed into heat. By reducing this resistance the brake action will be increased, so that it is possible to increase or decrease the brake action gradually as may be required. It will be seen that it is impossible to stop the load dead and hold it suspended in the air by the electric brake, because as soon as the generator stops revolving the electromotive force induced also stops. Then, of course, there is nothing to prevent the load from dropping, which necessitates another type of brake also being fitted. This brake need not be designed to hold the falling load, but only to brake it when it is nearly at rest.

Magnetically-released Brakes.

These brakes are usually fitted on to the motor spindle and are of the strap or clamp type. They are held off by the action of a solenoid or magnet electrically connected with the motor in such a

manner that when the current is cut off from the motor from any cause the magnet releases the spring or weight, as the case may be, and allows the brake to come into action. The solenoid commonly in use consists of a coil of wire connected in series with the motor and a plunger working up and down inside the coil. The weight of this plunger is nearly always sufficient to put the brake on without using another special weight on the brake lever. Solenoids should be so designed that their action is not delayed when the current has been cut off, due to residual magnetism. On the other hand, a too rapid application of the brake is to be avoided, since this has sometimes bent armature shafts.

To effect this the solenoid usually forms in itself a dashpot, the air being throttled in a small hole at the top of the body.

Arrangements are usually made in the winding of the solenoid to enable it to lift off the brake when the controller is on the first contact, otherwise the motor would drive against the brake.

With this type of brake it is usual to fit a hand release operated from the cage by means of a hand lever which pulls a small wire rope over pulleys, and is so attached to the brake lever on the crab as to lift the brake off for purposes of lowering the load by gravity. This cannot be done when a Weston type load brake is fitted, as with this brake the load has to be lowered by motor power.

Mechanical Brakes.

These are usually of the multiple-plate friction type, and are known as "Weston" brakes. They consist of a pinion mounted on a square thread which is cut in one of the intermediate driving shafts, with a number of plates or discs keyed on to an extension of this pinion. These are sandwiched between fixed plates or discs, which are keyed into an outer dust-proof case that serves as an oil bath. There is also a pressure disc which is keyed to the shaft. The outside of the dust-proof case is in the form of a ratchet. Mounted on a shaft, which runs parallel to the brake shaft, are pawls which fall into gear with this ratchet. The action of the brake is as follows: When lifting the load the resulting pressure on the pinion, due to the screw, holds the friction plates or discs hard up against the pressure disc, and the pawls having been lifted out of gear the whole brake revolves together without resistance. As soon as the lifting ceases and a slight reverse has taken place, the pawls fall into gear and the load is held secure by friction. In order to lower the load the motor must be reversed and run on light power, this having the effect of reducing the pressure on the friction faces and allowing the load to slip steadily.

Centrifugal Brakes.

Another mechanical brake is of the centrifugal or governor type. This brake is only used to prevent excessive lowering speeds, and consists of a disc or drum fitted with pockets on the periphery, usually four in number, which accommodate shoes. These shoes are fitted on the outside face with leather or "Ferodo" or other braking material, and being loose in their pockets are free to move outwards by centrifugal force due to the disc or drum being keyed to the revolving shaft or motor spindle. There is an outer casing which is stationary and fixed to the crab frame so that these flying shoes press against the inner rim of the casing, thereby braking the mechanism. The brake shoes are made of cast iron and operate against coil springs when flying outwards.

This type of brake is also used by some firms as a slipping wheel or clutch on the longitudinal travelling mechanism.

There are many variations of the types of brakes described, but to deal with them in detail would take up a good deal of space.

(Concluded.)

A FORTY-SEVEN HOUR WEEK.

Messrs. James Walker and Co. Ltd., makers of the well-known Lion Packing, have instituted a 47-hour working week at their works, Garford Street, West India Dock Road, London, E. We understand that the arrangement has given complete satisfaction to all concerned. The managing director of the firm, Mr. George H. Cook, has given the matter much thought and attention before putting it into operation. The arrangement is as follows: Monday, 8 a.m. to 5-30 p.m.; Tuesday, 7 a.m. to 5-30 p.m.; Wednesday, 7 a.m. to 5-30 p.m.; Thursday, 7 a.m. to 5-30 p.m.; Friday, 7 a.m. to 6 p.m.; Saturday, works closed; meal-time break, 12 p.m. to 1 p.m. It will be seen that Saturday is entirely free, and the employees thoroughly appreciate having their week-end, while the firm have an opportunity for repairs, etc., that was not present before. The short half day on Saturday will not, it is stated, lessen the firm's output. The managing director of Messrs. Walker is keen on doing the best thing possible for the workpeople generally, and no effort is to be spared to secure the harmonious working of all concerned.

INSTITUTION OF AUTOMOBILE ENGINEERS.

The Institution of Automobile Engineers brought its session to a most successful conclusion with meetings on May 7th and 8th, when papers were read by Mr. Chas. Day on "Diesel Engines," and Mr. E. Rilston on "Two-stroke Engines for Motor-cycles."

Twelve meetings have been held during the session, the various papers dealing with motor-cycle subjects, steel, engine tests, patents and electric vehicles, in addition to the two mentioned above.

The programme for next session appears to promise equally successful results, and papers have already been secured from Mr. Ricardo, Dr. Aitchison, Dr. Ormandy, Mr. W. M. Hackett and others. Among the subjects to be dealt with will be engine design, valve failures, volatile fuels, production of steel, tubes, producer gas for vehicles, cast iron for use in automobile construction etc., while it is hoped to obtain an important paper on American practice.

It is intended to hold a special session of the Institution during the period of the Olympia Show, which will be arranged in such a way as to give members an opportunity of meeting the President and Council and to bring them into closer touch with each other.

A useful feature of next session will consist in the reading of the papers not only in London, but in the various provincial centres in which a demand appears to exist, and where the subjects of the papers are connected with local industries.

Non-Ferrous Materials.—The following particulars are published of the stocks (exclusive of old metal and scrap) in this country in possession of the Minister of Munitions on May 1st, 1919:—Copper, 51,130 tons; spelter G.O.B., 26,912 tons; spelter refined, 7,057 tons; aluminium, 11,542 tons; soft pig lead, 109,012 tons; nickel, 2,567 tons; antimony regulus, 4,461 tons.

MECHANICAL LOAD BRAKES.

By D. Riley.

In a recent article in the pages of this journal dealing with dynamic brakes, it was stated that brakes of that class are really governors, and are not in themselves sufficient to control a hoisting gear. It is essential that all hoisting gears should be fitted with a brake capable of arresting and holding the load apart from any secondary brake that may be considered necessary.

Solenoid Brakes.

The general current practice for overhead travelling cranes, which are the commonest of all types of cranes, is to fit a solenoid brake, with or without hand release. In many cases this brake alone is considered sufficient, the exceptions being as dealt with in the writer's previous article, when the dynamic brake is fitted as a secondary brake.

American Practice.

The above may be said to be the general practice in this country and has given satisfactory results with a minimum of cost, but in America the practice differs, and almost invariably crane makers fit a mechanical load brake, which is considered essential in a first-class gear. From an engineering point of view, the mechanical load brake is a step nearer the ideal, and certainly where the duties are heavy this type of brake is safer and more reliable. After all, the brake gear is the heart and soul of any hoisting apparatus. There is no difficulty in hoisting a load, providing the necessary power is available, but there is a difficulty in dissipating the potential energy in the load when lowering it. This difficulty is aggravated as the load and the height of lift increases, and too much attention cannot be devoted to braking devices in hoisting machinery subjected to hard and continuous working.

Mechanical Load Brake.

When a mechanical load brake is fitted, it is not necessary to fit a dynamic brake, as the former type will adjust itself to the motor and absorb any force tending to produce acceleration outside the motor, and assuming this is not of the type that races, there is no possibility of the gear running up to a dangerous speed. It is necessary, however, to fit a solenoid brake, as will be shown later, to absorb the inertia of the motor armature or rotor in order to get fine adjustments of the load. In case the motors are of the type subjected to racing, as D.C. series-wound machines, the series solenoid provides a safeguard in virtue of the fact that it releases and allows the brake to come on with low currents.

Conditions of Control.

In reviewing these articles up to the present stage, we arrive at the following conclusions: That a hoisting gear can be perfectly controlled independent of the driver by fitting:—

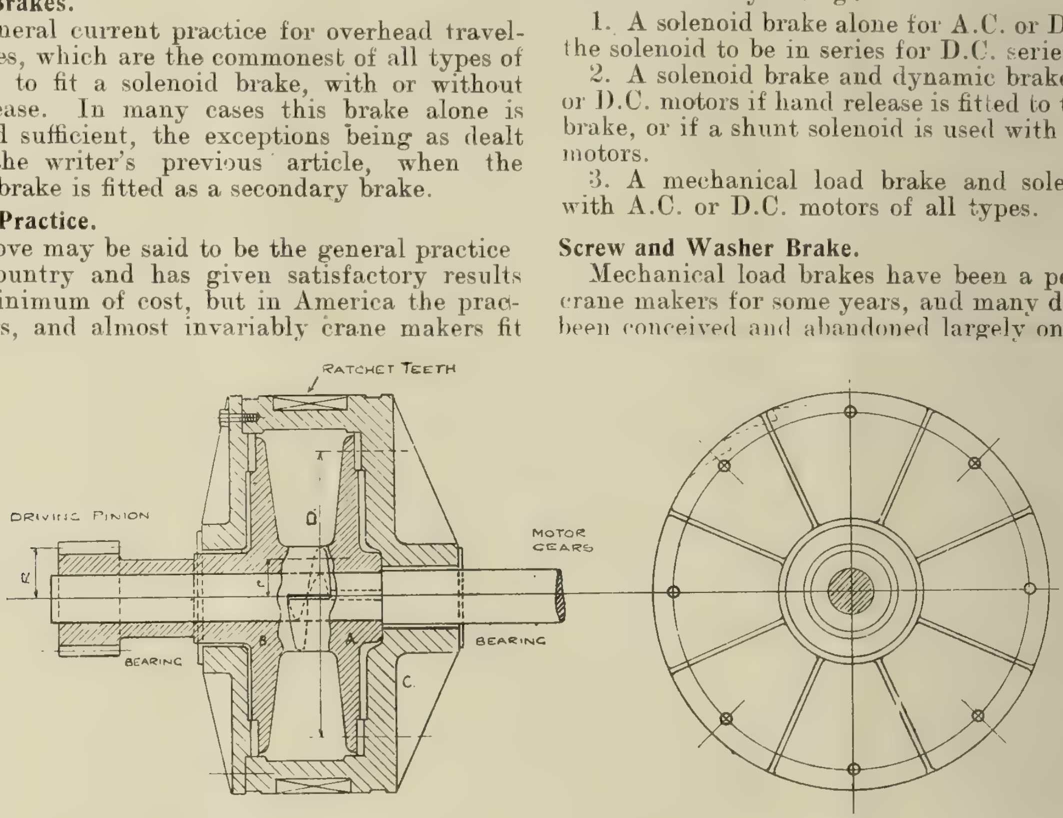
1. A solenoid brake alone for A.C. or D.C. motors, the solenoid to be in series for D.C. series motors.
2. A solenoid brake and dynamic brake with A.C. or D.C. motors if hand release is fitted to the solenoid brake, or if a shunt solenoid is used with D.C. series motors.
3. A mechanical load brake and solenoid brake with A.C. or D.C. motors of all types.

Screw and Washer Brake.

Mechanical load brakes have been a pet hobby of crane makers for some years, and many designs have been conceived and abandoned largely on account of cost and difficulty of manufacture. Amongst the principal types are the screw and washer brake and the coil brake. It is proposed to deal with the former type in this article, and Fig. 1 shows two views of a brake which has been used with success, and will serve the purpose of illustrating the following theory.

Method of Operation.

At the termination of each hoisting operation, when the motor is stopped, the driving pinion and disc B are reversed by the reaction of the load, and a close investigation will show that both discs A and B are locked against the outer casing C by the helix formed on the bosses of A and B. The casing C has ratchet teeth cast on the periphery which engage with two pawls fixed in a convenient position on the crab frame; thus a positive hold on the load is obtained. In lowering, the motor is reversed, and through the medium of the helix the pressure between the discs and the casing is relieved, and so long as the motor leads, the whole of the gear is allowed to rotate in the lowering direction. It will be seen that any tendency of the load to overhaul the



Mechanical Load Brakes.—Fig. 1.

motor will be checked by the pressure which will obtain between the discs and the casing; thus a hunting motion is set up. Now it is only necessary to have perfect control of the motor to complete the arrangement, hence the necessity of a solenoid brake. The latter brake will pull up the motor immediately the current is cut off, otherwise the motor would continue to run for some time, due to the inertia of the armature or rotor, and accuracy in adjusting the load would be impossible.

Design of Brake.

In designing a brake of this type it is customary to allow an excess over the theoretical braking effort required at the discs of 50 to 100 per cent. Let

W = the pull at the periphery of the hoisting barrel.
Q = the braking effort required at the discs.
ρ = the velocity ratio between these two points.
μ = the forward efficiency.
μ_1 = the reversed efficiency.

Then, as in the last problem,

$$Q = \frac{W}{\rho}\mu_1 = \frac{W}{\rho}\left(2 - \frac{1}{\mu}\right).$$

Having found Q, we can now proceed with the brake details. Let

P = pressure on teeth of driving pinion.
R = radis at pitch circle of driving pinion.
D = mean dia. of discs A and B.
p = pressure on helix normal to axis.
r = mean radius of helix.
α = angle of lead of helix at mean radius.
ϕ = angle of friction at helix.
c = coefficient of friction at discs.

Then, assuming we allow 100 per cent excess on the calculated value of Q,

$$Q\frac{D}{2} = 2PR$$

$$QD = 4PR. \tag{1}$$

Also $p = \frac{PR}{r}$, and $2\frac{p}{\tan(\alpha+\phi)}c = Q$,

and from these equations

$$Q = 2\frac{PR}{r\tan(\alpha+\phi)}c. \tag{2}$$

Substituting (2) in (1), we get

$$\frac{2PR}{r\tan(\alpha+\phi)}cD = 4PR$$

$$\therefore \frac{cD}{2r\tan(\alpha+\phi)} = 1$$

and $$\tan(\alpha+\phi) = \frac{cD}{2r}$$

or $$\tan(\alpha+\phi) = c\,\frac{\text{mean dia. of discs.}}{\text{mean dia. of helix.}}$$

If we deduct the angle ϕ from the above results, we shall get the angle of lead of the helix. For brakes of this type c may be taken as .08, and the angle of friction at helix as 5 deg. For radiation of heat the total friction surface at the discs should not be less than 1 square inch for 3,000 to 2,500 foot lbs. per minute. The angle of lead of helix for the brakes experimented with worked out at about 8 deg., and the brake was run in oil.

RAILWAY ELECTRIC TRACTION.

By W. A. BARNES.

Large Electrification Projects.

One of the most important questions that will arise in the immediate future is the further electrification of railways not only in this country, but all over the world. Prior to 1914 heavy electric traction was rapidly developing, but whilst it has necessarily had to lie fallow during recent years, there is no doubt that the events which have happened in that period will accelerate very materially that development.

It is a matter which is intimately associated with reconstruction after peace is declared, and one which we shall be forced to consider in order, amongst other things, to conserve our coal stocks and use them in the most efficient and economical manner, to replace rolling stock which has been requisitioned on active service, and to improve our existing methods of transportation.

Look where you will, at the present time projects are being put forward for large electrification schemes. The United States are going in for it whole-heartedly, and are proving its reliability and adaptability for the heaviest haulage and severest services in the world.

The Swiss have a proposal to electrify the whole of their federal railways. Italy, which already has a considerable mileage electrified, is preparing to proceed with all its northern railways. Belgium, which by the time peace is declared will possess very little rolling stock, and will be in the position to start with a clean slate, has the question of electrifying the whole of her railways in hand. In this country, too, it has proved its worth, more especially for high-density suburban passenger traffic.

The railway companies of this country have provided a vast amount of rolling stock for war purposes, some of which will return, but a great proportion of it will be in that state which will require early replacement. This, combined with the necessity for conserving coal, will tend to cause a rapid advance in the electrification of railways. The chief difficulty, however, which presents itself at the present time to those who have the problem of electrification before them, is that no approach to standardisation has yet been obtained, and one is confronted with several systems, each of which is enthusiastically supported by its champions.

Points to be Considered.

The points to be considered in adopting any system of traction are: (1) Reliability of service; (2) cost of installation, maintenance, and operation; (3) simplicity of operation—*i.e.*, passengers or goods should be transported to their destination with the least delay, the least cost to the company, and the greatest convenience to the public.

At the present time there are only two systems of traction in use for railway purposes—steam and electric—so that the issue lies between them. It is foolish, however, to regard this as a battle to the death, for though the proportion of electric traction to steam traction will gradually increase, there will be spheres of work for both steam and electricity for many years to come, and perhaps, who knows, electric traction may have to bow its head to aerial transport.

Electric v. Steam Traction.

Before dealing with the merits and demerits of the various electrical systems, a word might be said as to what are the peculiar qualifications of electric traction which would lead one to decide on its adoption in preference to steam. The question is largely one of finance, since railways are not run from philanthropic motives, and the fact that they are, for the greater part, steam-driven at the present time is a great obstacle from a financial point of view to a drastic change to another system of traction.

The position of the railway companies is that they are in possession of good steam rolling stock which is earning money, and to scrap this ruthlessly and replace it by electrically-driven stock is to put on the electric system the burden of not only earning a return on the extra expenditure entailed by its installation, but also on the capital value of the stock which has been taken out of commission. It therefore follows that the change from steam to electric traction must be gradual, though there is no doubt it will be expedited by reason of having to replace a vast amount of steam stock lost during the war.

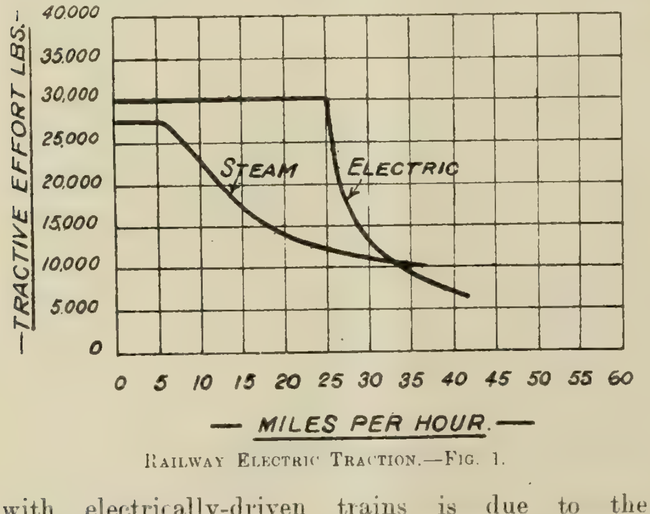
Advantages Claimed for Electric Traction.

The advantages that can be claimed for electric traction are principally:—

(*a*) Increased acceleration and retardation.
(*b*) Higher schedule speed.
(*c*) More frequent service.
(*d*) Increased capacity of existing tracks.
(*e*) Less rolling stock.
(*f*) Ease of operation in and out of terminal stations.

Increased Acceleration.

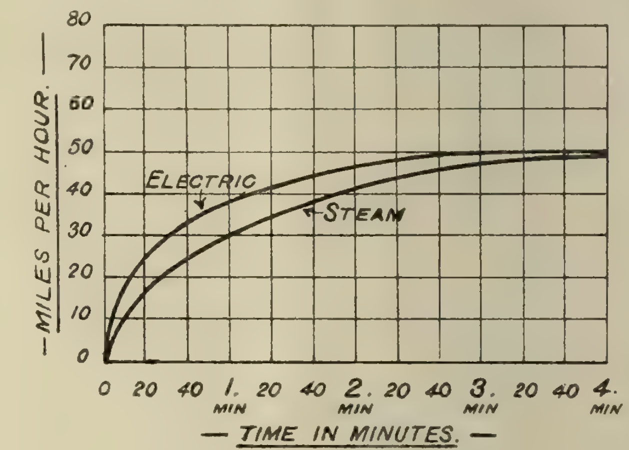
Taking these points in the order given, the increased acceleration which it is possible to obtain



Railway Electric Traction.—Fig. 1.

with electrically-driven trains is due to the characteristics of the traction motor as compared with those of a steam engine. This can readily be seen from Fig. 1, which compares the tractive efforts of a steam and electric train with similar starting efforts. The initial tractive effort of the steam train falls very rapidly, and at 25 miles per hour is only 45 per cent of the maximum, whereas with the electric train the maximum tractive effort is maintained up to this speed, and is consequently available for accelerating the train. This, coupled with the fact that the number of driving axles of an electric train is double or more than double than that of a steam train, and that the whole weight of a motor car or electric locomotive can be utilised for adhesion, thus minimising slipping, accounts for the increased acceleration it is possible to get.

This high acceleration, however, is only of advantage with services where the stations are close



Railway Electric Traction.—Fig. 2.

together, and the stops consequently frequent. This can be seen from Fig. 2, which compares the accelerating of a steam and electric train of equal weight and similar maximum speeds. During the first four minutes the average speed, and consequently the distance travelled, of the electric train is much higher than the steam, but the longer the run after the first four minutes (the point where both attain their maximum speed) and the less the increased acceleration of the electric train shows to advantage. It has been established that steam traction has reached its limit, so far as rapid traffic with frequent stops is concerned, and any attempt to force the steam locomotive to run to electric timings results in prohibitive costs, both in running and maintenance.

(*To be continued.*)

The Coming Importance of South America for Engineering.—Now that the war is over many things are beginning to revive in the South American Republics. Public and private works and undertakings, suspended by the war, are about to be taken in hand again, and several important British firms are already busy catering for contracts. The Patagonian, Chaco, Uruguayan and other railways are still in many cases incomplete. Schemes for asphalting roads in the Argentine, for motor and tractor traffic, are being considered in view of the rapid development of agriculture, and numerous bridges will require building both there and in other republics, where rivers are to be dredged, bridged and generally rectified. A very big scheme is also brewing, and is being considered by the Buenos Aires authorities in conjunction with the Uruguayan Minister at Brazil, who is now at Buenos Aires partly for that purpose. It is to exploit the falls of Salto Grande, in the Rio Uruguay, with a view to supplying electric current to the whole coast of that river and also right up to Montevideo and Buenos Aires. It was also proposed to utilize the Iguaza Falls for the purpose, but, although they are larger, they are too far away. As will be seen, there is money to be spent by the South American Republics, and it will be the fault of our contractors if they do not secure a good share of it—despite American competition.

Patent Applications.

APPLICATIONS FOR PATENTS.

Alldays and Onions. Internal-combustion engines. 7,993. March 29th.
Anderson, C. E. Valves and cocks. 7,390. March 25th.
Antrobus, W. Furnaces. 7,898. March 29th.
Arnold, J. J. Appliance for preventing piston rings of gas, oil, etc., engines from springing out of their grooves. 7,552. March 26th.
Beal, G. D. Rotary engines, etc. 7,947. March 29th.
Bell, W. T. Internal-combustion engines. 7,442. March 25th.
Blake, J. Steam generators. 7,475. March 25th.
British Westinghouse Electric and Manufacturing Co. Coils for electro-magnets. 7,620. March 26th.
Broderick W. Locking-device for screwed caps of grease-cups, etc. 7,825. March 28th.
Burdon, W. M. Apparatus for liquid-fuel firing of steam-boilers. 7,943. March 29th.
Burdons Ltd. Apparatus for liquid-fuel firing of steam-boilers. 7,943. March 29th.
Cameron, W. Internal-combustion engines. 7,533. March 26th.
Cannon, C. S. Internal-combustion engine. 7,546. March 26th.
Cesbron, F. C. M. Ignition devices for internal-combustion engines. 7,287. March 24th. (France, March 23rd, 1918.)
Challis, P. Pistons for internal-combustion engines, steam-engines, pump plungers, etc. 7,955. March 29th.
Cheswright, L. K. Internal-combustion engines. 7,443. March 25th.
Cole, E. Oil-fuel burners. 7,696. March 27th.
Cross, J. W. Driving or power-transmission belts. 7,290. March 24th.
Donohoe, F. Boiler and damper. 7,682. March 27th.
Douglas, J. T. Internal-combustion engines. 7,442. March 25th.
Douglas Motors Ltd. Pistons. 7,507. March 26th.
Douglas, W. W. Pistons. 7,507. March 26th.
Gill, D. O'B. Valve caps of internal-combustion engines. 7,615. March 26th.
Hempel, A. J. N. Carburettors for internal-combustion engines. 7,586. March 26th.
Hobson, H. Internal-combustion engines. 7,529. March 26th.
Imray, O. (Blair and Co.). Flexible coupling. 7,302. March 24th.
Moore, S. Bramley-. Power transmission. 7,572. March 26th.
Osborne, F. Collar for shaftings, spindles, etc. 7,407. March 25th.
Pomeroy, J. Hydraulic power-transmission mechanism. 7,286. March 24th.
Simms, C. E. Internal-combustion engines. 7,993. March 29th.
Smith, W. T. Steam generators and furnaces. 7,896. March 29th.
Snarry, J. W. Valve-gear for internal-combustion engines. 7,659. March 27th.
Spence, W. L. Double-reduction gear. 7,681. March 27th.
Twigg, R. Belt-fastener. 7,556. March 26th.
Westinghouse Air Brake Co. Fluid-pressure breaking apparatus. 7,311. 7,312. 7,313. March 24th.
Yates, D. H. Uniflow steam-engine cylinders, etc. 7,508. March 26th.

COMPLETE SPECIFICATIONS ACCEPTED.

1915.

16,975.—Ruston and Chorlton. Internal-combustion engines. Dec. 2nd, 1915.
16,995.—Caldwell. Fuel supply of internal-combustion engines. Dec. 2nd, 1915. (Cognate Application, 1,762/16.)
17,882.—Ricardo. Internal-combustion engines. Dec. 22nd, 1915.

1917.

The number at the end of each paragraph is that under which the Specification will be printed and abridged, and all subsequent proceedings will be taken.

17,228.—Yearsley. R. A. Internal-combustion engines. Nov. 22nd, 1917.—124,229.

1918.

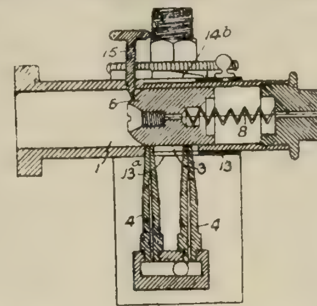
4,657.—Evans, C. Water-tube boilers. Mar. 16th, 1918.—124,256.
4,851.—Packer, J. H. Oil and other liquid separator and cleaner. Mar. 19th, 1918.—124,264.
4,978.—Sturmey Archer Gears Ltd., and Archer, J. Variable-speed gear for velocipedes. Mar. 21st, 1918.—124,279.
6,779.—Wood, W. R. Drying fuel supplied to boiler furnaces or the like. April 22nd, 1918.—124,314.
13,083.—Sperling, O. Flexible shaft connection. Aug. 25th, 1917.—118,623.
14,076.—Boyd, J. Emergency boiler-flue stopper. Aug. 30th, 1918.—124,375.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

INTERNAL-COMBUSTION ENGINES.

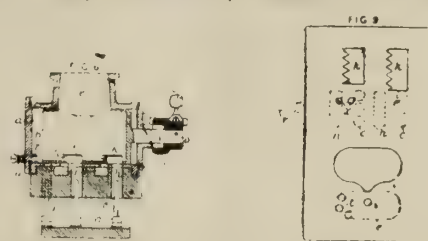
119,714.—E. D. ROSE, Westerlee, Dugdale Road, Radford, H. FLETCHER, 19, Widdrington Road, and A. W. COLLIER, 11, Dugdale Road, all in Coventry.—Oct. 17th, 1917.—The casing 1 of a spray carburettor has, in its lower surface, an air inlet aperture 3 into which project fuel nozzles 4 which are brought into action in succession by a solid plunger 6 which controls proportionately the air inlet. The plunger is actuted by a Bowden cable 8 and its closing movement is limited by an adjustable screw 15 so as to keep one of the nozzles uncovered more or less to serve as a pilot nozzle. The effective area of the air inlet 3 may be independently controlled by a rotatable sleeve 13 having four ports 13*a* therein of different sizes. The sleeve is held in its



adjusted position by a spring-mounted plunger 14*b*. The float is spherical, has rigidly attached thereto a conical valve and, in its lowest position, rests on a curved sheet of gauze which serves to filter the fuel passing to the nozzles. The nozzle and air inlets may be surrounded by a dust-excluding cover.

INTERNAL-COMBUSTION ENGINES.

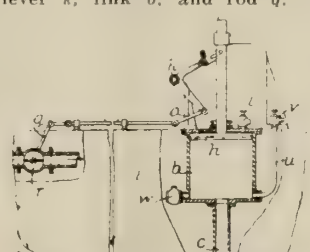
119,725.—T. J. DISTURNAL, Maney Hill Road, Sutton Coldfield, Warwickshire.—Oct. 24th, 1917.—Carburettors for use with liquid or gaseous fuel, *e.g.*, of the type described in Specifications 6423/15 and 103 520, in which one or more groups of nozzles *d* discharge into choke tubes *c* controlled by a throttle-valve *b* capable of axial and rotary movement, are provided adjacent each group of choke tubes with an air chamber *i*, the inlet to which is controlled by a suction-actuated valve, the outlet *h* being controlled by the serrated edge of a port *k*, the other plain edge of which controls the outlets from the choke tubes. The valves of the chambers *i* may be differently loaded so as to come into action



in succession. The ports *k* in the throttle valve may be, as shown in the development in Fig. 9, of different lengths so that by rotation of the valve, the choke tubes may be brought into action in succession. At starting, an auxiliary nozzle *p* is employed in conjunction with a by-pass *r* and holes *t*, *v*, Fig. 9, which in the closed or nearly closed position of the throttle valve, register with the outlet passage *e*. The by-pass is controlled by a screw *u*. For admitting additional air when running idle, apertures *x* are provided in the throttle valve over the outlets *h*. The throttle valve is rotated by a lever *l* fixed to the spindle *o* and is moved inwardly by suction to an extent depending upon the position of a projection on a lever *m* which engages a cam face *n*. The valve may be moved axially in the reverse direction by rotating the lever *m*.

SPEED-GOVERNORS.

119,728.—J. W. MONSTER, s/s "Barking," Crossness, Abbey Wood, London, Oct. 26th, 1917.—A marine engine governor comprises a vertical cylinder *b* open at its lower end to the sea by means of a pipe *c* and containing a piston *h* connected to the throttle, etc., valve *r* by a lever *k*, link *o*, and rod *q*. The cover of the

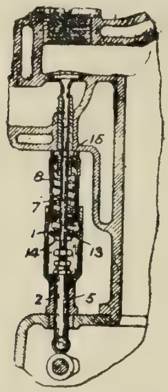


cylinder has an air-valve *i*, which is normally open, and the lower part of th cylinder has a snifting or non-return valve *w*, and is connected by a pipe *u* to a hand-operated cut-off air valve *v*. The rise and fall of the ship produces variations of pneumatic pressure under the piston *h* and so operates the throttle, etc. The movement of the piston may be retarded by closing the valve *i* and adjusting the valve *v*.

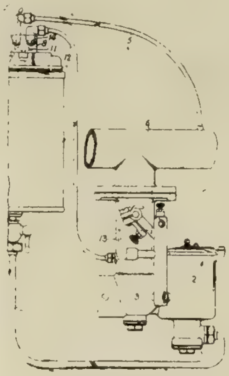
INTERNAL-COMBUSTION ENGINES.

119,735.—A. G. L. NEIGHBOUR, and H. C. W. NEIGHBOUR, 1, Oak Grove, Brighton, Victoria, Australia.—Nov. 8th, 1917.—To facilitate the removal of a valve or the replacement of a closing spring, the stem 7 is surrounded by a casing 1 which, normally, is secured

by screwing, or otherwise, to a guide 2, but which, to compress the valve spring, is disconnected from the guide 2 and screwed on to a member 8 connected by a bayonet joint or by other means to a guide 15. The casing 1, when in its uppermost position, engages a washer 13 on the valve stem, thus leaving the cotter 14 free to be extracted prior to the withdrawal of the valve. By disconnecting the member 8 from the guide 15, the compressed spring may be withdrawn, with the casing 1, between the end of the valve stem and the tappet 5. According to a modified construction, the casing 1 is in permanent engagement with the member 8 and is screwed into its innermost position to compress the valve spring. It is held normally by a clip. A modified construction is described in which the screw connection between the parts of the casing is replaced by a bayonet joint.



Patent 119,736.



Patent 119,768

INTERNAL-COMBUSTION ENGINES.

119,768.—C. F. L. KING, 138, Bristol Road, Edgbaston, Birmingham.—Jan. 5th, 1918.—In liquid fuel supply apparatus wherein fuel is raised by suction from a main to an auxiliary tank, whence it is discharged by gravity to the carburettor, the auxiliary tank is placed in communication as sources of suction with the induction pipe and the carburettor choke tube or other restricted portion of the air conduit, the communicating pipes being provided with non-return valves so that the pipe in which the suction is weaker is automatically cut out. The auxiliary tank 1 feeds the float chamber 2 through a pipe 4 and is connected through a pipe 5 with the induction pipe 6 and, through a pipe 12, with a restricted portion of the induction passage such as the choke tube 13. The pipes connect with passages 7, 11 in a fitting 8 and are provided with non-return valves 10, 14. The valve in that pipe in which the stronger suction exists is open and the other is closed. The pipe 12 may be connected directly to the upper portion of the tank 1.

INDEX TO ADVERTISERS.

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— THE —

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EDITORIAL.

MECHANICAL APTITUDE.

EDUCATIONALISTS are aware of the vast difference in initial bent which exists between pupil and pupil, they are aware more particularly of such divergence, because it hampers the conformity so desirable to a syllabus. Long ago this difficulty was ascribed to a double dose of original sin which afflicted the immature human, to-day the tendency is toward enhancing rather than retarding individual development along the lines of natural endowment. The former aim was to turn out duplicates of a set pattern, and only those whose mentality was apt along the stated lines obtained the full benefit. The present ideas lead to a greater flexibility, more distinctive training, and less set conclusions as to the outcome of tuition.

It was easier for the schoolmaster to have one method and one goal, it was only the boy who was recalcitrant, as a consequence many forced into distasteful studies promptly forgot even their rudiments, and got their real education subsequent to schooldays. The present case is an inversion of previous practice, a certain amount of elementary essential is requisite, but, subsequent to this, training can be infinitely varied to suit individual temperament and aptitude. Personal inclination on the part of the youth is not altogether a trustworthy guide, and discipline is bound to be irksome to the unfledged if not unformed youngster.

The subject takes new shape because the fitting of round pegs into round holes represents one of the satisfactions of life. Changing a career invariably means some sacrifice; it may mean lifelong penalty; it certainly does involve loss of seniority, so to speak. For this reason any real guidance in immaturity is precious, and if right, is amply repaid later.

There is too great a tendency to assume because the boy finds pleasure in using a hammer, manipulating an electric bell, or amateur craft of any description, that he is destined for a mechanical career. The pleasure of making something is common to the entire human species, there is an hereditary instinct for tools, from which very few are free. Such instinctive use of the hands is apt to be mistaken for mechanical aptitude, to the undoing of the recruit in later years. Neither fancy or taste on the part of the boy can be held sufficient for the choice of a career.

One thing which has always been operative in selection, and has greatly assisted the survival of the fittest, has been the conditions of workshop life. The boy lacking grit, of poor physique, and without real aptitude, finds engineering conditions not to his taste, and early quits the scene.

There is a sense in which modern college training divorces the student from reality, and while the intellectual stimulus may keep interest from flagging, he may find that although he knows quite a lot about engineering problems, when he faces reality he is without that mechanical aptitude essential.

For engineering, effort is one of the most severe schools extant, its discipline is hard, it rewards are never inordinate, its physical, mental, and moral demands are inflexible; nothing but real aptitude will provide the driving force sufficient to find that interest and pleasure, without which a mechanical career is a vain thing. There is really no other profession which makes the same insistent and varied demands, which taxes all facilities quite in the same manner and, given the right material, upbuilds more surely a destructive type. Genuine mechanical

aptitude will be a good enough substitue for quite a lot of examining of academic kind, for it will seek explanations in evolutionary terms, bring to the problem of the hour a swift and specific intelligence, it is in short a natural gift.

In many senses engineering is the most democratic of all professions, it associates together in mutual co-operation handicraft of exquisite calibre and the greatest mental acumen of specific type open to human intelligence; they need not be combined in the one individual, for utility exists within the borders of the engineering world for men of most diverse gifts.

But the real temperament which finds peculiar satisfaction in such activity must be the impelling force, and mechanical aptitude for want of anything more definite covers this essential. Without it there can be no abiding interest, and it is not a common possession which can be developed under any system of training or schooling.

There is a vast and fundamental divergence between design and production; they meet on common ground by reason of mechanical aptitude, and usually have fairly close cognisance of the problems of either.

Engineering education is yet an unsolved problem, for distinction of an intellectual kind may prove for want of the quality discussed to hamper rather than help. In course of time the initial aptitude develops into an instinct, quite as remarkable in its way as the natural habits of the lower creation, quite as certain in its selection and results. The mind faced with complex alternatives makes swift choice of the precise expedient, without much if any hesitation; conviction is very real, and among trained men very similar. Unlike an academic problem, first principles do not figure, yet, when analysed scientifically, the results of sheer practice obey law. This is instructive mechanical aptitude added to experience and training, and is the result of knowledge just as much or more than scientific development from a rational beginning. It is artistry in practice rather than scientific methods in being. Deplore as we may the contemptuous rule of thumb, there is much more behind it than sheer strength allied to brute intelligence.

All the great engineers have been distinguished by this unerring instinct, careful though they may be to check up their selection by fact and figures to be safe, it has been mechanical aptitude which has been the real guide, a visualisation of sub-conscious character springing from familiarity and similarity. All the pioneer work has been so performed and, although we now take larger evolutionary strides, they would have been impossible but for the knowledge gained and reduced to system based on the results of aptitude in practice.

Real experiment rather than intellectual reasoning has been a guide, and this is the case even to-day with almost every novel problem. The adventure could hardly be undertaken save in the spirit of practical sense, perhaps another alternative to the term mechanical aptitude.

Like all intangible possessions, those who have it know, those who have it not will not understand; its manifestations are everywhere evident in engineering connections; its wants may account for many inexplicable failures both human and otherwise.

It discriminates the best from second-rate, perhaps why some one product is superior has a bearing on reputation; certainly, without it, engineering activity would suffer relapse; it stimulates all invention, all new design.

THE INDUSTRIAL SITUATION.

By Charles Gregory.

In my previous article I made some reference to the threatened strike by the now famous Triple Alliance, and pointed out that the present period of calm might probably presage a storm. My surmise looks like being justified if the Government persists in its present policy.

The publication of certain confidential orders to the officers in command of His Majesty's Forces has aroused a very pronounced feeling of indignation in the ranks of the working classes, and unless some explanation is speedily forthcoming from those who were primarily responsible for the said orders there will be very serious trouble for somebody in the very near future.

Prussianism.

It is lamentable that just when all broad-minded men are interested in bringing about industrial peace that those responsible for the good government of the country should take action which can only result in the creation of discord and strife.

Prior to the last General Election Mr. Lloyd George made a special point of the fact that he was out to put down Prussianism, and yet he is the head of a Government which is prepared to institute the very same methods in our own country. During the last four years no prominent man has been so bitter in his attacks on militarism as the Premier, and yet, with a Government organised by himself more than any other person, militarism is in the ascendant, as it never was before.

Trades Unionists Lose Faith.

Trade Unionists, as a result, are rapidly losing faith in political action, and are drifting steadily in the direction of Syndicalism. Hence we find that the more intelligent of them are asking for a lead for industrial action, which they claim will be more effective than any political action they can possibly engage in.

Quadruple Alliance.

In the unions connected with the engineering industry in particular there is an increasing desire, on the part of thousands of members, to see the Triple Alliance become the Quadruple Alliance, by the inclusion in same of the engineering trades organisations. If such an alliance becomes an established fact, then I fear that there are some troublous times in store, and that our boasted commercial supremacy will become a thing of the past. The pity of it all is that such irritating action on the part of responsible Ministers should become known just when the industrial atmosphere was becoming clearer.

Settlement of Matters in Dispute.

The settlement of the piecework question in the engineering and allied trades is practically complete. The question of diluted labour was also

to be decided in the near future is the number of rapidly righting itself, and the only important point hours which shall constitute the normal week in the engineering and shipbuilding trades.

The 44-hour Week.

The indications are that in the ballot now taking place *re* a 44-hour week, an overwhelming majority will be found in favour of same. In Manchester district, at any rate, the vote indicates a majority of almost 40 to 1 in favour. Moreover, there is a large number of workmen who consider that the abolition of Saturday work entirely will be beneficial both to the employers and employed. Saturday morning has for a long time past in many large concerns been regarded as wasted time. A well-known manager of one of the largest works in the Manchester district, on one occasion, told a deputation of workmen that "Saturday morning's work was largely composed of the settling up of debts between workmen and the filling in of football coupons." And there is no doubt that in many large works that is a correct estimate of the value of Saturday morning, so far as the employers are concerned. If the 44-hour week is agreed upon, it would be a very wise policy, in my opinion, to arrange the hours so that the total week's work could be accomplished in five days, and conclude on Friday evening.

The extended weekly vacation would ensure better and more work being done than has ever been the case hitherto, largely due to the better physical conditions of the workers, which would undoubtedly be the result.

Increased Production.

The great cry to-day is for increased production, and this is the direction in which it will be obtained. If the workers are to speed up to any appreciable extent then their periods of rest and relaxation must of necessity be extended. A man may run a hundred yards or so in very fast time, but the speed he attains in doing so will affect him as much physically as a man running a mile at a much slower pace, and the same theory is applicable to all pursuits requiring the exercise of either mental or manual exertion.

Agitation not of the Minority.

It is no use saying that these agitations for shorter hours and better conditions are the work of a minority of irresponsible hot-heads; such is not the fact. The men who are responsible for these agitations are the very men who carry on the local work of the various unions. They are the intelligent section, the men who fill the branch and district offices, and who, without any regard for pay, spend a very great proportion of their leisure in filling the official positions in the branches, and carrying on all the immense detail work that must be done in connection with any progressive organisation. The workman who spends a considerable portion of his time in "picking winners and backing losers," or in filling up football betting coupons, is not the sort of chap that counts in trade unionism to-day. The men who count to-day are the keen students of economics, history, and sociology, men who have an ideal and are prepared to work and fight for it, and it is well, when considering the reasons for industrial unrest, to understand clearly that the men who are at the bottom responsible for it are not lazy, idle loafers on the look-out for a cosy berth, but keen-witted, and in many cases eloquent men, who have taken every advantage of the educational facilities that have been afforded them.

Therefore, in discussing the great questions affecting industry as a whole, it is well that this fact should be kept in mind, otherwise some not very agreeable surprises may be in store for those who prefer to ignore it.

Brute Force no Use.

Prussianism in industry is the one thing which, more than any other, is calculated to ruin our trade and commerce, and that, I fear, irretrievably. The recent happenings in the world have proved that brute force is opposed to all rational progress, and that mind is now, and always will be, superior to matter; and what is true in the political world is true also in the world of industry and art.

Income Tax.

Another matter which is becoming important is the question of the levying of income tax upon wages. The South Wales miners are merely the vanguard in what promises to become an overwhelming force, demanding the raising of the limit upon which the tax shall be paid. Engineers as a class are keenly interested in this latest movement, and the reasons are obvious.

The working engineer to-day who is earning a wage, say, of £4 per week, taking the year through, claims to be in a much worse position financially than he was in the pre-war days with half that amount. The purchasing power of a pound note to-day is certainly not more than 9s. 8d., as compared with pre-war times. The advance in wages, particularly in the engineering industry, has not by any means kept pace with the advance in the price of commodities. Taking this district as an example, wages have advanced in the engineering trade by 90 per cent, and food, clothing, and other commodities by 103 per cent. In addition to this, the man earning, say, an average of £4 per week, pays some £6 per year in income tax. This, added to the difference in prices, leaves him about 16 per cent worse off than he was in pre-war days; and it is upon these grounds that the engineers, as well as the miners, are claiming exemption from payments, unless they are in receipt of an annual income of £250.

What the outcome of the miners' agitation will be remains to be seen, but all things considered, they have a fair case to go to the jury, so to speak. All these things are part of the aftermath of war, but the problems they create, can be solved by common sense and honest dealing.

The Providence Iron Works, Belgium, the plant of which comprises five blast furnaces will, according to what has been stated, be able to start one of their blast furnaces in some six to 12 months' time. The Cockeril Co., with seven blast furnaces, expects to have two in operation within a few weeks, and four more in the course of four to six months. At the Ongrée-Marihay Works (eight blast furnaces) four of which destroyed; at the Ongleur Works (four blast furnaces) two will soon be in operation, and three blast furnaces of the Sambre-et-Moselle Works are expected to be ready for use in the course of some three months, if the necessary raw materials can be promptly secured

VIRGINIAN MALLET LOCOMOTIVES.

Ten Mallet locomotives having a tractive power of 147,200 lbs., working compound, and 176,600 lbs., working simple, are now being delivered to the Virginian Railway by the American Locomotive Company. The authorities of the Virginian Railway have the problem of handling a constantly increasing volume of traffic on an exceptionally difficult part of the system.

The portion of the lines between Elmere and Clark's Gap on the Deepwater division, a distance of about 14 miles, has a grade for the last $11\frac{1}{2}$ miles of 2.07 per cent with maximum compensated curves of 12 deg. For the first $2\frac{1}{2}$ miles the grade is 0.5 per cent. This 14 miles is all single track, and includes five tunnels, which compel the use of an absolute block. This is the crucial part of the entire system, as all the tonnage of the Virginian Railway passes over it. During the last 11 years Mallet locomotives have been employed in handling this traffic. The size and power of these locomotives have progressively advanced to keep pace with the growth in volume of traffic.

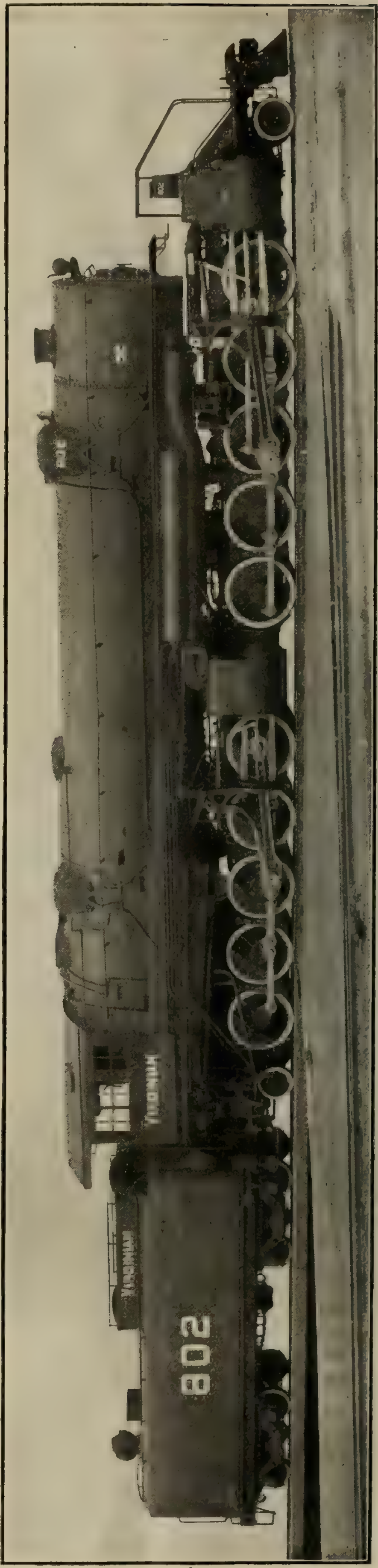
The first instalment consisted of four engines of the 2—6—6—0 type, with tractive power of 70,800 lbs. Next in sequence were eight of the same wheel arrangement, but with a tractive power of 90,000 lbs. The third instalment consisted of one engine of the 2—8—8—2 type, with a tractive power of 100,800 lbs. The fourth lot was six engines of the 2—8—8—2 type, with a tractive power of 115,000 lbs.

At present trains passing over the mountain section are operated by one 2—6—6—0 type Mallet road engine, with a tractive power of 90,000 lbs. at the head and two 2—8—8—2 Mallet pusher engines, with a tractive power of 115,000 lbs. each behind. The maximum tractive power which can thus be applied to a train is 320,000 lbs., which enables them to handle 4,500 tons in 60 cars having an average weight for car and load of 75 tons.

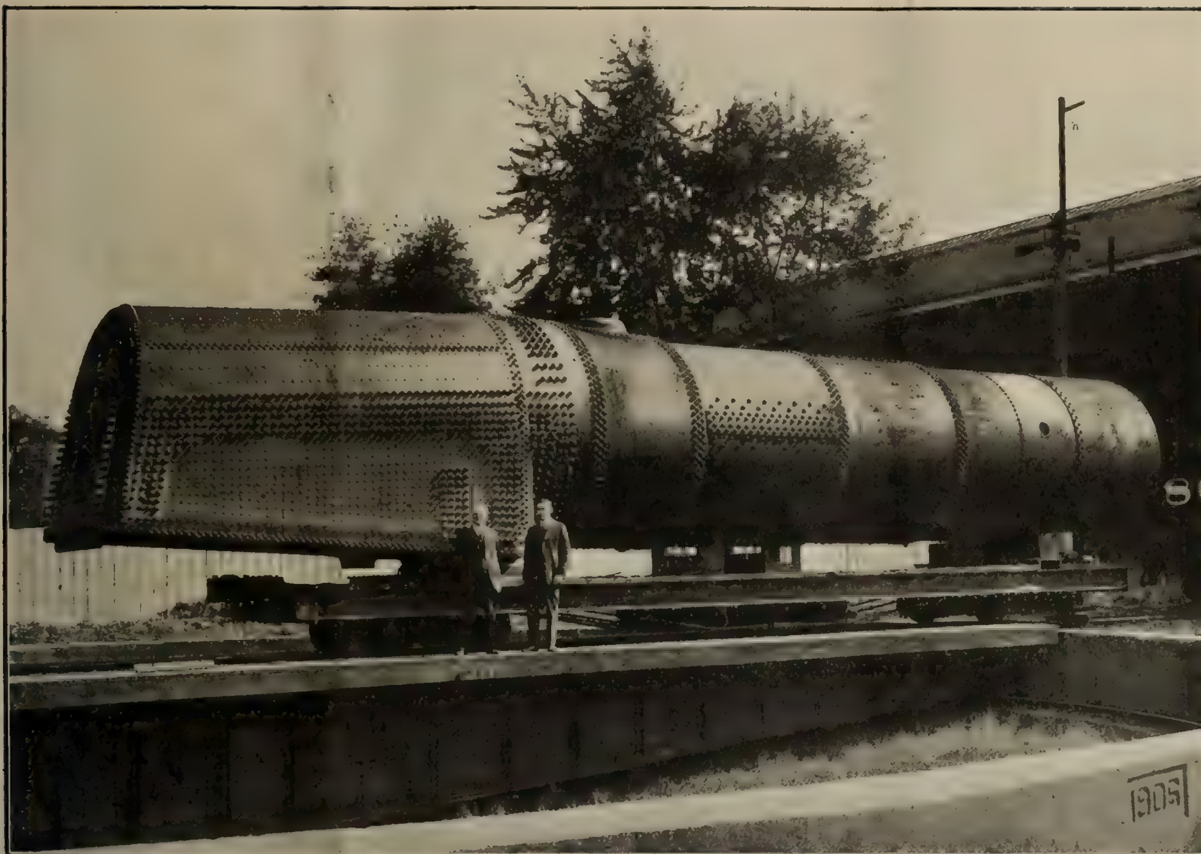
The traffic volume is still growing, and as the track is single, and as it is not desired to increase the number of engines on any train above three, it has been found necessary to put still larger locomotives into service. The enormous locomotives under discussion were developed in order to accomplish this result.

Upon receipt of these new engines trains will be composed of one of the 2—8—8—2 Mallet engines, having a tractive power of 115,000 lbs., at the head and two of the new 2—10—10—2 Mallet engines, having a tractive power of 147,200 lbs. behind, giving a total tractive power for the train of 409,400 lbs. This train will have a tonnage of 5,850 tons, the equivalent of 78 cars, having an average weight for car and load of 75 tons.

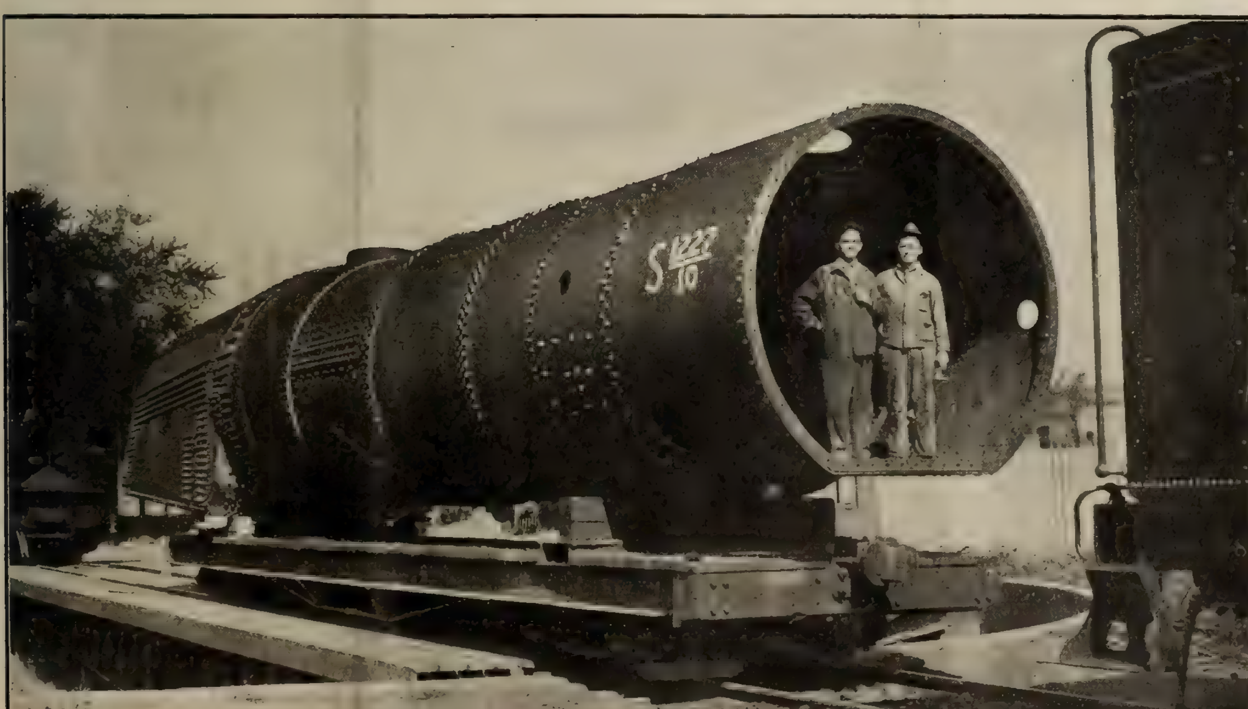
The 2—8—8—2 type Mallets, which will be used on the head end of the train, were built by the American Locomotive Company in 1912 and 1913. At that time these engines were the most powerful locomotives in the world. The following comparison shows the extent in which these 2—8—8—2 type



Virginian Mallet Locomotive.



Virginian Mallet Locomotive—Side View of Coiler..



Virginian Mallet Locomotive—End View of Boiler..

engines were exceeded in the new 2—10—10—2 type:—

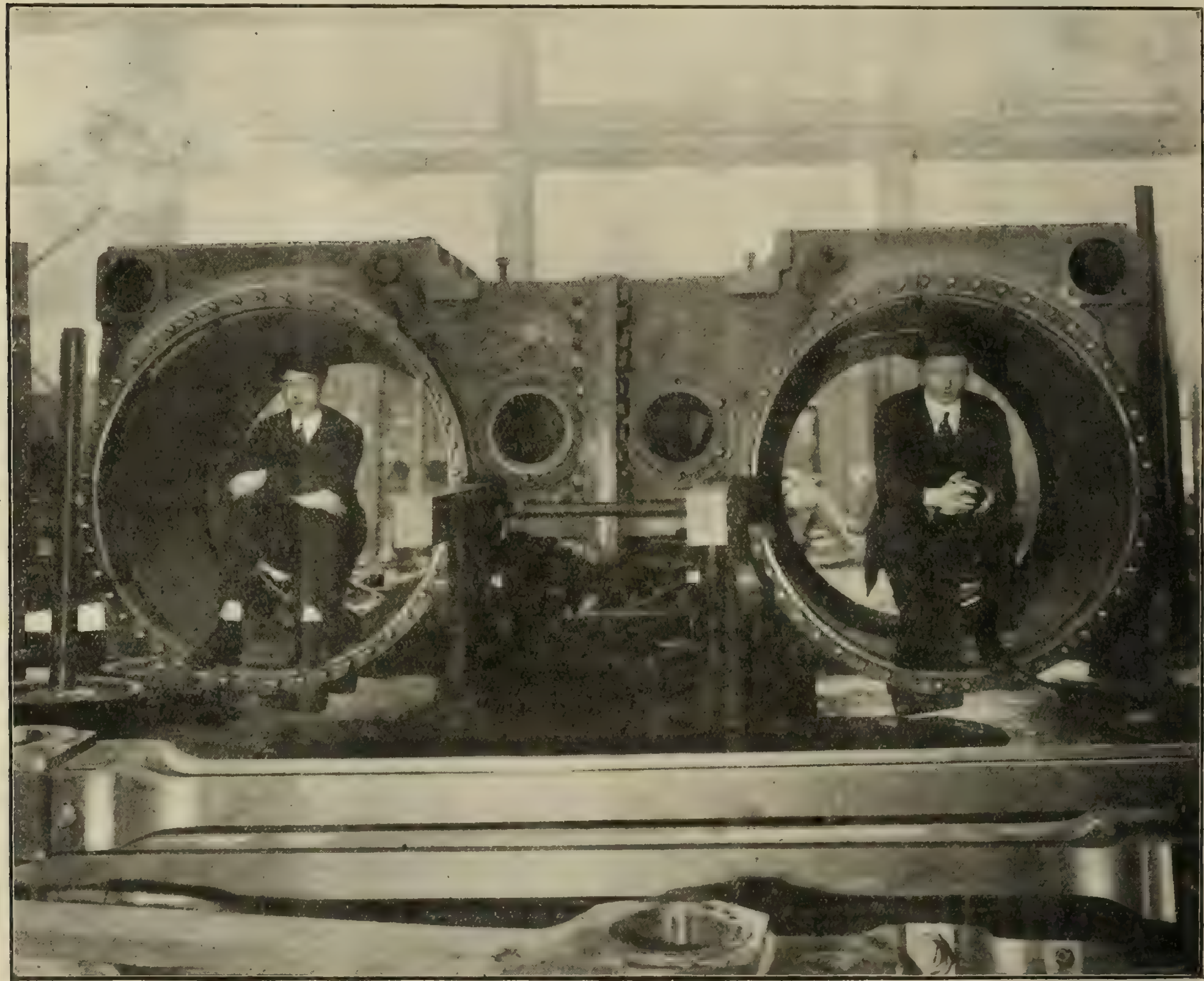
	2-8-8-2 type.		2-10-10-2 type.		% increase.
Total weight of engine .... lbs.	540,000	..	684,000	...	26·6
Total weight, engine & tender... „	752,000	...	898,300	...	19·5
Heating surface ....sq. ft.	6,909	...	8,606	...	24·5
Superheating surface .... „	1,311	...	2,120	...	61·7
Tractive power, compound ......lbs.	115,000	...	147,200	...	28
Tractive power, simple .... „	138,000	...	176,600	...	28

Apart from the enormous weight and power of the locomotive as a whole, some of the dimensions of the boiler are impressive as showing the extent with which all limits were exceeded in its design and construction. At the first course it is 105½ in. in diameter outside, while the outside diameter of the largest course is 112¾ in. The barrel is fitted with 381 tubes 2¼ in. in diameter, and 70 flues 5½ in. in diameter and 25 ft. long. A combustion chamber 36 in. long is included. The firebox is $181^{1}/_{16}$ in. long and 108¼ in. wide. A total heating surface of 8,605 square feet and a superheating surface of 2,120 square feet are obtained.

The design as a whole follows the builder's ordinary practice, differing from previous design only in modifications made necessary by the increased power.

These engines were built at Schenectady, N.Y., and the contract called for delivery completely erected and ready for service on Virginian Railway Company tracks. The shipping arrangement required considerable planning before the railroad carriers could be convinced that they could safely accept and move *via* their lines locomotives of such size and weight.

In preparing for shipment of large locomotives it is first necessary to submit diagrams showing the estimated height and width clearance dimensions, and the distribution of weights on each axle to the operating or engineering department of each carrier over whose line it is intended to route the shipment in order to secure their agreement to handle the shipment when offered to their lines. If some projection exceeds the carriers' clearance limitations, an effort is made to meet the objection by removing that part, if possible, and re-applying it on arrival at destination. Or, if the weights are too heavy for some trestle or bridges *via* a natural route, an effort is made to find a way to ship *via* a detour route.



VIRGINIAN MALLET LOCOMOTIVE—END VIEW OF CYLINDERS

These large locomotives presented an unusual problem. It was impossible to ship them completely assembled and moving dead on their own wheels. After the consideration of many plans it was finally decided to leave the boiler on the frames, but trimmed of all outside parts and projections. The cab, low-pressure cylinders, and other certain parts were removed and the remaining skeleton with tender shipped on their own wheels. Each locomotive required one flat, one gondola, and one box car to carry the loose and detached parts.

Authority was eventually secured for shipping in this manner, although under special operating instructions and *via* detour routes.

The full route used was as follows:—

New York Central Railroad, Schenectady to Newberry, Jct.

Pennsylvania Railroad *via* Columbia, Perryville, Newark, Del., Porter, Delmar, and Cape Charles.

Float from Cape Charles to Port Norfolk, Va.

N. and P.B.L. Railway, Norfolk and Western, and Virginian Railway to Princetown, W. Va.

The Norfolk and Western Railroad was used only in the Norfolk district, as the Norfolk and Portsmouth Belt Line Railway could not handle these engines direct to their point of connection with the Virginian Railway. These engines could only be handled one at a time from Cape Charles to Norfolk, as there was only one float—the latest one built—capable of handling the shipment under special instructions. Each locomotive was accompanied by a messenger, who had sleeping quarters fitted up in the cab, which was loaded on a flat car. Approximately, two weeks has been the actual running time from Schenectady, N.Y., to Princeton, W. Va.

A NEW THEORY OF PLATE SPRINGS.

By David Landau and Percy H. Parr.

(*Continued from page 294.*)

Paper 2.

In our first paper we made a liberal effort to show the fundamental principles underlying our new theory of plate springs, and to indicate briefly, though succinctly, the irrationality of the old theory. No direct mathematical proof was offered to substantiate our statements regarding the errors of the old theory, for it seemed to us that such proof was not demanded; the facts themselves, as marshalled into evidence, being deemed to be, as the lawyers say, *prima facie* evidence of its inaccuracy.

The reader who has followed our exposition with sufficient care will, however, doubtless find some objections, and be inclined to take exception to some of the statements as not having been proved; this may be the case, to an even greater degree, with the engineer who has had much experiemce in the use of plate springs, and especially to him who has kept a record, or compiled statistics, of the breakages of spring plates.

Our intention in the first paper was to avoid tediousness in the exposition of this apparently simple but really very complex subject, hence, it was, in some ways, but a foreword to this more complete and prolix exposition. Much, necessarily, had to be left to the present paper; even this one will not include all of the many elements that have to be considered, certain of which must be left for the third and (for the present) concluding paper. We shall preamble the present exposition by a few remarks which have been verified by tests and experience.

Most experienced spring makers have noticed that the short plate is the one which breaks most often on ordinary plate springs; so far then our theory has offered an intelligible—and as we hope to show, ultimately, a true—explanation of the observed facts. On the other hand, there are many exceptions to this breakage of the short leaf. It is a fact beyond contradiction, that with very many springs, other plates break with equal or, in some rare cases, with even greater frequency than do the short plates. For instance, in a series of endurance tests of several hundreds of springs, made a few years ago, the majority of the breakages occurred in the master leaves: in several cases the intermediate leaves broke, but only in a comparatively small number of cases was the fracture confined to the short leaf. Why should this be so? Indeed, from the exposition of our theory, as given so far, it might be reasonably asked, "If your theory is correct, how is it possible that any plate other than the short one can break first?"

It may also be mentioned as an established fact that many commercial springs, constructed from the point of view of low cost of production combined with reasonable safety in use, are made of ordinary qualities of "carbon spring steel" except for the master leaves, which are made of high-grade "alloy spring steels."

Why this practice if the theory we have so far expounded be correct? And how can we, on the basis of our theory, account for the many apparent exceptions to it? The answers to these questions are fairly simple, but the formal proofs are tedious and long.

In order to allay the desire of the reader to understand the reasons of the apparent—and they are only apparent—discrepancies between our theory and the facts of practice, we shall give a brief "word-picture" first and afterwards proceed to the formal mathematical proof.

There are two principal causes which operate to induce a leaf, in a leaf spring, other than the short one to break first: for the moment we shall name only one of these, and that is the tapering of the ends of the leaves.

This one cause — tapering — produces the most astonishing modifications in the reactions and, of course, the stresses in the leaves. The "life" of the spring is increased or decreased in proportion as this seemingly minor, but really most important, detail is given proper consideration in the design and in the manufacture. Our theoretical investigations and long practical experience justifies our making immediately the definite statement that, next to the homogeneity of the molecular structure of the finished product, the tapering of the ends of the leaves is of the greatest importance, and in order to obtain the best results in the longevity of a plate spring the tapering should be carried out with mathematical exactitude.

We believe that we have, in a very great neasure, solved this most important question of tapering on scientific principles, and our researches appear to prove that we have been the first to define the precise effects of tapering and its resultant effect on the strength and life of leaf springs.

Before the publication of the present paper, if anyone had made an inquiry of the engineer, or even of the experienced spring maker, as to what was the effect of tapering the ends of the leaves on the "strength," the "life" or on the "endurance" of a spring, the average answer would have been about as follows: "The tapered-end leaves look better, but are of no particular advantage;" and as confirmatory evidence, if that be needed, "the railroad springs are scarcely ever tapered." A more astute engineer might "guess" that "the tapered-end leaf is better," but as to why, how, and how much better? he could give no answer. We shall, in fact, show later on that the effect of tapering may be either for the better or for the worse—the good effects produced have limitations, although, in general, tapering is beneficial as compared to no tapering. The mathematical proof is rigorous but not too easy, and an attempt will first be made to give a mental concept of the physical effects.

(*To be continued.*)

WATER-TUBE BOILERS AT POWER STATIONS.

SOME CAUSES OF DETERIORATION AND EXPLOSION.

By Edward Ingham.

One of the principal items in the running costs of an electric power station is the expense incurred in maintaining the boilers in safe condition. At most stations large ranges of water-tube boilers are installed, and since the conditions of working are usually far more severe than those which obtain with ordinary factory boilers, the question of preventing deterioration calls for much care and intelligence on the part of those in charge. The defects from which water-tube boilers suffer, and what is perhaps of more importance the causes of these defects, do not appear to be thoroughly understood by many boiler engineers, and for this reason the following remarks should prove useful.

The water-tube boiler, such as the Babcock and the Stirling, has been designed to develop a maximum of power in a minimum of space. A large amount of heating surface is obtained by providing numerous small tubes, which are placed in the path of the hot gases, and through which the water is made to flow. Since the work of evaporation is mostly done in these water tubes, it is there that defects are principally met with.

Tube defects comprise internal corrosion and blisters, external corrosion, bulging and distortion, and bending of the tubes.

Internal corrosion is generally caused by acids present in the feed water. Owing to the inaccessibility of the tubes, it cannot be satisfactorily examined, and is in consequence always liable to proceed until the metal is wasted to a serious extent. For this reason the use of corrosive water is very objectionable.

Blisters are caused by the expansion of very small volumes of gas which have become imprisoned in the metal during the manufacture of the tube. Naturally, it is the metal on the water side which is forced down as the imprisoned gas expands, so that a blister is really an internal defect (see Fig. 1). Blisters are objectionable because they partially close up the tube and interfere with cleaning. In serious cases it becomes necessary to renew the tube, but small blisters are not, as a rule, regarded as important defects. There is, of course, a possibility that the outer metal, being unprotected by the direct contact of the water, may suffer from overheating and eventually burn away, in which case the internal pressure of the water, now that the pressure of gas has been removed, might force back the bulged metal, eventually leading to a rupture. To obviate this possibility, the defective part should, if accessible, be frequently examined on the fireside for signs of overheating, so that, if necessary, the tube may be renewed before an accident occurs.

External corrosion is often the result of damp on the outer surfaces of the tubes, the damp being caused by leakage, but it is more often caused by the abrasive action of small particles of fuel, combined with the action of corrosive compounds present in the furnace gases. When the trouble is due to damp, the remedy is in most cases simple—*i.e.*, keep the external surfaces of the tubes dry by removing all sources of damp. When abrasive and chemical action are responsible for the mischief, a change in the fuel will sometimes prevent further trouble.

Water-tube Boilers.—Fig. 1.

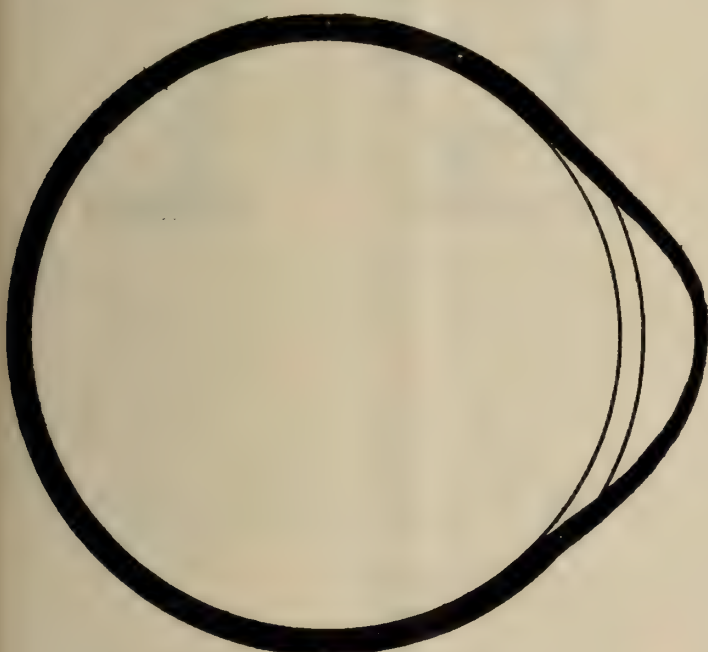
External wasting can be best discovered by caliping the tubes at a number of places and comparing the diameters so obtained with the original diameter. The defect should be particularly looked for near the ends, where the tubes are expanded into the headers, since leakage at the joints may set up the trouble. The tubes directly exposed to the intense heat of the furnace should receive careful attention.

Close visual examination will sometimes serve to discover external corrosion, but since the tubes often waste very smoothly it cannot always be depended upon. Hammer testing is of great value in finding thin parts, if applied with care and intelligence.

Bulging and distortion are mostly caused by overheating, but in some instances are the result of imperfections in the tube material. Tube material defects are, however, nowadays of comparatively rare occurrence.

In the working of water-tube boilers, every precaution should be taken to prevent overheating, which in serious cases may give rise to rupture and explosion. The trouble may be brought about in a numbers of ways; forcing the fires and so producing an excessively high temperature in the furnace will sometimes cause trouble, but in most cases overheating is caused by accumulations of deposit or by grease. A thin coating of scale or the slightest quantity of grease may produce very serious overheating.

Local bulges, as illustrated by Fig. 2, are somewhat common defects, and frequently result from overheating caused by small patches of deposit. When once a bulge forms, a pocket in which scale will tend to collect is produced, so that there is a



Water-tube Boilers.—Fig. 2.

tendency for further overheating to occur, followed by enlargement of the bulge. After a time the upper portion of the bulge begins to burn away, and eventually the metal may become thinned to such an extent that rupture and explosion of the tube are the consequence. In one instance which we have in mind, where an explosion occurred in this way, the owners of the boiler were heavily fined by the Board of Trade Commissioners for having ignored the advice offered by the insurance company to purify the water before passing it into the boiler.

It is always advisable to keep a sharp look-out for any evidences of bulging; a small bulge, whilst it may be simply an isolated defect, due to a patch of scale, may, on the other hand, be an indication that general overheating is taking place, in which case many of the tubes will suffer sooner or later. In all cases where evidences of bulging are met with, it is well to investigate thoroughly the conditions of working. Tubes in which the bulging is of a pronounced character should be renewed without delay in order to minimise the risk of explosion. Many firms appear to be extremely neglectful in the matter of renewing defective tubes. Rather than go to a little timely trouble and expense they prefer to run the risk of the tubes exploding. There is a somewhat common impression that an explosion of a water tube rarely involves serious consequences, but this is a mistake, and a glance through some of the Board of Trade reports on boiler explosions will serve to show that the results of an explosion are frequently fatal.

When general overheating occurs in a water-tube boiler, undue expansion of the tubes takes place; this expansion must be taken up either by the tubes bending or by the headers yielding.

Bending of the tubes is objectionable for a number of reasons. In the case of horizontal tubes, if the bending take place in a vertical and downward direction, there is, in serious cases, a tendency for scale and deposit to collect along a considerable portion of the length of the tubes, involving risk of further overheating.

In all cases of bending more or less severe strains are thrown upon the headers; if these be of cast iron, as in some of the older types of boiler, risk of fracture is involved.

Another objection to bending of the tubes is that it has a tendency to loosen the hold of the tube ends in the headers or the drums, the result of repeated straining and movement. In serious cases this involves some risk of the tubes being drawn out of the headers or the drums, unless the ends are satisfactorily bell-mouthed. Only recently an explosion of a Stirling boiler occurred at Liverpool in this way.

A small amount of bending, say $\frac{1}{2}$ in. or $\frac{3}{4}$ in. at the worst part, need not, as a rule, be regarded as serious, but when it exceeds this, and particularly if the headers are of cast iron, the question of renewing the tube before long should receive careful consideration. In all cases where the bending exceeds 2 in., the tube should be renewed without delay.

The steam, water, and mud drums are, of course, liable to suffer from defects, such as corrosion and fractures, but in general these parts give comparatively little trouble, and owing to limitations of space we cannot discuss the defects here. The drums are mostly accessible, so that corrosion, fractures, or other troubles can usually be discovered without much difficulty.

On the other hand, the tubes are for the most part inaccessible, and there must always be some uncertainty as to their real condition. For this reason all possible care and attention should be given to the attainment of satisfactory conditions of working. The use of a pure feed water—*i.e.*, a water comparatively free from corrosive ingredients, scale-forming matter, dirt, and grease—is of fundamental importance. There can be no question that a bad water causes rapid deterioration of water-tube boilers. Frequent cleaning and scaling is another important consideration, but one which is often neglected at electric power stations. In no case should scale be allowed to accumulate in the tube to a greater extent than $^1/_{16}$ in. Even with good

water the boiler should not, as a rule, be worked for more than 1,000 hours without having the tubes cleaned and scaled, particularly the bottom rows and the back end circulating tubes; the latter tubes, it may be added, are liable to choke up, prevent the circulation, and lead to shortness of water.

Intelligent supervision and frequent thorough inspection by qualified men are further important considerations. Owing to the difficulty of making a thorough visual inspection, a hydraulic test, applied every two or three years, will be found very useful in discovering defective tubes, leakages, etc.

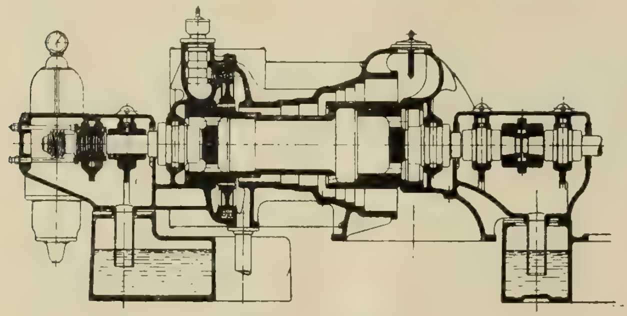
If a boiler be fed with good water, cleaned regularly, skilfully tended, and periodically inspected, there is no reason why it should not be maintained in good condition indefinitely, providing always that it is of good design and construction.

MODERN STEAM TURBINES.

By J. Humphrey.

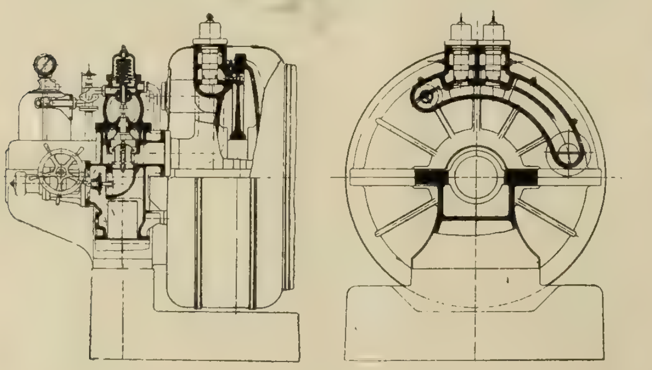
(*Continued from page 295.*)

The Brown Boveri steam turbine built by Richardsons, Westgarth and Co. Ltd., is a disc and drum machine possessing several novel and interesting features. From the section, Fig. 85, it will be seen



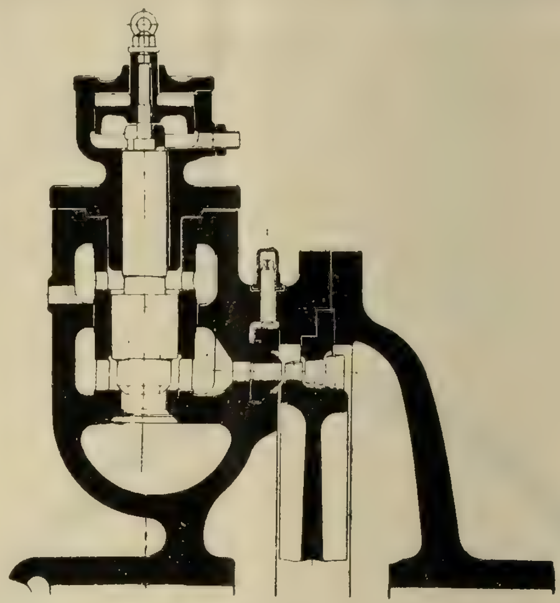
Steam Turbines.—Fig. 85.

that the low-pressure dummy piston is fitted at the exhaust end of the turbine, whilst at the high-pressure end of the drum there is an internal heating chamber which is in direct communication with the



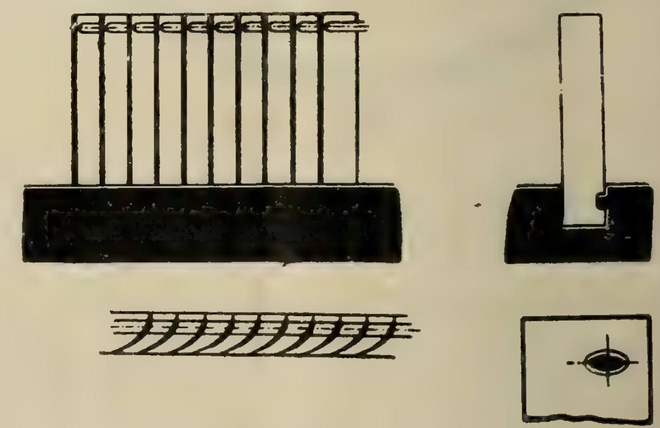
Steam Turbines.—Fig. 86.

boiler steam, the result being that there is practically no difference between the temperature at the periphery and centre of the drum. The makers claim that it is possible to start the machine up from the cold condition in a very short space of time without preliminary heating. The arrangement of the nozzle valves and the governor gear at the high-pressure end will be understood from Fig. 86, whilst a separate section of one of the nozzle valves is shown in Fig. 87. These valves open and close automatically in accordance with the load, thus reducing throttling



Steam Turbines.—Fig. 87.

to a minimum, and enabling the maximum possible energy to be extracted from the high-pressure steam. The valves are simply opened by the steam pressure behind the inlet valve, and as the load increases this pressure rises and opens several valves in proper sequence, the opening and closing of the valves being done so smoothly that there is no increase or decrease in the speed and hand adjustment is unnecessary. If the turbine be fitted with reaction blading throughout, an automatic by-pass valve is fitted for



Steam Turbines.—Fig. 88.

enabling the machine to deal with overloads. The illustrations already referred to will enable the general construction of the turbine to be understood, and we may therefore pass on to the details. To begin with, the reaction blading is not caulked in the usual manner, but the root of each blade is notched as shown in Fig. 88, and the grooves into which the

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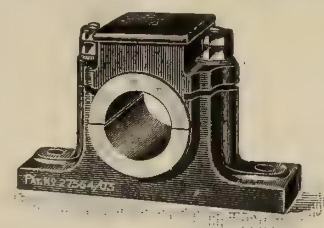

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Beam 6 in. × 3 in. × 15½ lbs. per foot.

Ft.	0			10			20			30			40		
Ft.	c.	q.	lbs.	c.	q.	lbs.	c.	q.	lbs.	c.	q.	lbs.	c.	q.	lbs.
0		..		1	1	15·0	2	3	2·0	4	0	17·0	5	2	4·0
1	0	0	15·5	1	2	2·5	2	3	17·5	4	1	4·5	5	2	19·5
2	0	1	3·0	1	2	18·0	3	0	5·0	4	1	20·0	5	3	7·0
3	0	1	18·5	1	3	5·5	3	0	20·5	4	2	7·5	5	3	22·5
4	0	2	6·0	1	3	21·0	3	1	8·0	4	2	23·0	6	0	10·0
5	0	2	21·5	2	0	8·5	3	1	23·5	4	3	10·5	6	0	25·5
6	0	3	9·0	2	0	24·0	3	2	11·0	4	3	26·0	6	1	13·0
7	0	3	24·5	2	1	11·5	3	2	26·5	5	0	13·5	6	2	0·5
8	1	0	12·0	2	1	27·0	3	3	14·0	5	1	1·0	6	2	16·0
9	1	0	27·5	2	2	14·5	4	0	1·5	5	1	16·5	6	3	3·5

50			60			70			80			90			Ft.
c.	q.	lbs.	c.	q.	lbs.	c.	q.	lbs.	c.	q.	lbs.	c.	q.	lbs.	Ft.
6	3	19·0	8	1	6·0	9	2	21·0	11	0	8·0	12	1	23·0	0
7	0	6·5	8	1	21·5	9	3	8·5	11	0	23·5	12	2	10·5	1
7	0	22·0	8	2	9·0	9	3	24·0	11	1	11·0	12	2	26·0	2
7	1	9·5	8	2	24·5	10	0	11·5	11	1	26·5	12	3	13·5	3
7	1	25·0	8	3	12·0	10	0	27·0	11	2	14·0	13	0	1·0	4
7	2	12·5	8	3	27·5	10	1	14·5	11	3	1·5	13	0	16·5	5
7	3	0·0	9	0	15·0	10	2	2·0	11	3	17·0	13	1	4·0	6
7	3	15·5	9	1	2·5	10	2	17·5	12	0	4·5	13	1	19·5	7
8	0	3·0	9	1	18·0	10	3	5·0	12	0	20·0	13	2	7·0	8
8	0	18·5	9	2	5·5	10	3	20·5	12	1	7·5	13	2	22·5	9

Weight of Beam, advancing by inches.

Ins.	1		2		3		4		5		6		7		8		9		10		11		12		Ins.
Weight.	q.	lbs.	q.	lbs.	q.	lbs.	q.	lbs.	q.	lbs.	q.	lbs.	q.	lbs.	q.	lbs.	q.	lbs.	q.	lbs.	q.	lbs.	q.	lbs.	Weight.
	0	1·29	0	2·58	0	3·87	0	5·16	0	6·45	0	7·74	0	9·03	0	10·32	0	11·61	0	12·90	0	14·19	0	15·5	

Weights of Lengths of Rolled Steel Sections.

Beam 6 in. × 3 in. × 15½ lbs. per foot.

Ft	0			100				200				300				400			
Ft.	c.	q.	lbs.	t.	c.	q.	lbs.	t.	c.	q.	lbs.	t.	c.	q.	lbs.	t.	c.	q.	lbs.
0		..		0	13	3	10	1	7	2	20	2	1	2	2	2	15	1	12
10	1	1	15	0	15	0	25	1	9	0	7	2	2	3	17	2	16	2	27
20	2	3	2	0	16	2	12	1	10	1	22	2	4	1	4	2	18	0	14
30	4	0	17	0	17	3	27	1	11	3	9	2	5	2	19	2	19	2	1
40	5	2	4	0	19	1	14	1	13	0	24	2	7	0	6	3	0	3	16
50	6	3	19	1	0	3	1	1	14	2	11	2	8	1	21	3	2	1	3
60	8	1	6	1	2	0	16	1	15	3	26	2	9	3	8	3	3	2	18
70	9	2	21	1	3	2	3	1	17	1	13	2	11	0	23	3	5	0	5
80	11	0	8	1	4	3	18	1	18	3	0	2	12	2	10	3	6	1	20
90	12	1	23	1	6	1	5	2	0	0	15	2	13	3	25	3	7	3	7

500				600				700				800				900				Ft.
t.	c.	q.	lbs.	t.	c.	q	lbs.	t.	c.	q.	lbs.	t.	c.	q.	lbs.	t.	c.	q.	lbs	Ft.
3	9	0	22	4	3	0	4	4	16	3	14	5	10	2	24	6	4	2	6	0
3	10	2	9	4	4	1	19	4	18	1	1	5	12	0	11	6	5	3	21	10
3	11	3	24	4	5	3	6	4	19	2	16	5	13	1	26	6	7	1	8	20
3	13	1	11	4	7	0	21	5	1	0	3	5	14	3	13	6	8	2	23	30
3	14	2	26	4	8	2	8	5	2	1	18	5	16	1	0	6	10	0	10	40
3	16	0	13	4	9	3	23	5	3	3	5	5	17	2	15	6	11	1	25	50
3	17	2	0	4	11	1	10	5	5	0	20	5	19	0	2	6	12	3	12	60
3	18	3	15	4	12	2	25	5	6	2	7	6	0	1	17	6	14	0	27	70
4	0	1	2	4	14	0	12	5	7	3	22	6	1	3	4	6	15	2	14	80
4	1	2	17	4	15	1	27	5	9	1	9	6	3	0	19	6	17	0	1	90

Ft.	1000				2000				3000				4000				5000			
Weight.	t.	c.	q.	lbs.	t.	c.	q.	lbs.	t.	c.	q.	lbs.	t.	c.	q.	lbs.	t.	c.	q.	lbs.
	6	18	1	16	13	16	3	4	20	15	0	20	27	13	2	8	34	11	3	24

6000				7000				8000				9000				10000				Ft.
t.	c.	q.	lbs.	t.	c.	q.	lbs.	t.	c.	q.	lbs.	t.	c.	q.	lbs.	t	c.	q.	lbs	Weight.
41	10	1	12	48	8	3	0	55	7	0	16	62	5	2	4	69	3	3	20	

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Weights of Lengths of Rolled Steel Sections.

Beam 7in. × $3\frac{3}{4}$ in. × 17 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	Ft.
0	..	1 2 2	3 0 4	4 2 6	6 0 8	7 2 10	9 0 12	10 2 14	12 0 16	13 2 18	0
1	0 0 17	1 2 19	3 0 21	4 2 23	6 0 25	7 2 27	9 1 1	10 3 3	12 1 5	13 3 7	1
2	0 1 6	1 3 8	3 1 0	4 3 12	6 1 14	7 3 16	9 1 18	10 3 20	12 1 22	13 3 24	2
3	0 1 23	1 3 25	3 1 27	5 0 1	6 2 3	8 0 5	9 2 7	11 0 9	12 2 11	14 0 13	3
4	0 2 12	2 0 14	3 2 16	5 0 18	6 2 20	8 0 22	9 2 24	11 0 26	12 3 0	14 1 2	4
5	0 3 1	2 1 3	3 3 5	5 1 7	6 3 9	8 1 11	9 3 13	11 1 15	12 3 17	14 1 19	5
6	0 3 18	2 1 20	3 3 22	5 1 24	6 3 26	8 2 0	10 0 2	11 2 4	13 0 6	14 2 8	6
7	1 0 7	2 2 9	4 0 11	5 2 13	7 0 15	8 2 17	10 0 19	11 2 21	13 0 23	14 2 25	7
8	1 0 24	2 2 26	4 1 0	5 3 2	7 1 4	8 3 6	10 1 8	11 3 10	13 1 12	14 3 14	8
9	1 1 13	2 3 15	4 1 17	5 3 19	7 1 21	8 3 23	10 1 25	11 3 27	13 2 1	15 0 3	9

Weight of Beam, advancing by inches.

In.	1	2	3	4	5	6	7	8	9	10	11	12	In.
Weight.	lbs. 1·41	lbs. 2·83	lbs. 4·25	lbs. 5·66	lbs. 7·08	lbs. 8·50	lbs. 9·91	lbs. 11·33	lbs. 12·75	lbs. 14·17	lbs. 15·58	lbs. 17	Weight.

Weights of Lengths of Rolled Steel Sections.

Beam 7in. × $3\frac{3}{4}$ in. × 17lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	0 15 0 20	1 10 1 12	2 5 2 4	3 0 2 24	3 15 3 16	4 11 0 8	5 6 1 0	6 1 1 20	6 16 2 12	0
10	1 2 2	0 16 2 22	1 11 3 14	2 7 0 6	3 2 0 26	3 17 1 18	4 12 2 10	5 7 3 2	6 2 3 22	6 18 0 14	10
20	3 0 4	0 18 0 24	1 13 1 16	2 8 2 8	3 3 3 0	3 18 3 20	4 14 0 12	5 9 1 4	6 4 1 24	6 19 2 16	20
30	4 2 6	0 19 2 26	1 14 3 18	2 10 0 10	3 5 1 2	4 0 1 22	4 15 2 14	5 10 3 6	6 5 3 26	7 1 0 18	30
40	6 0 8	1 1 1 0	1 16 1 20	2 11 2 12	3 6 3 4	4 1 3 24	4 17 0 16	5 12 1 8	6 7 2 0	7 2 2 20	40
50	7 2 10	1 2 3 2	1 17 3 22	2 13 0 14	3 8 1 6	4 3 1 26	4 18 2 18	5 13 3 10	6 9 0 2	7 4 0 22	50
60	9 0 12	1 4 1 4	1 19 1 24	2 14 2 16	3 9 3 8	4 5 0 0	5 0 0 20	5 15 1 12	6 10 2 4	7 5 2 24	60
70	10 2 14	1 5 3 6	2 0 3 26	2 16 0 18	3 11 1 10	4 6 2 2	5 1 2 22	5 16 3 14	6 12 0 6	7 7 0 26	70
80	12 0 16	1 7 1 8	2 2 2 0	2 17 2 20	3 12 3 12	4 8 0 4	5 3 0 24	5 18 1 16	6 13 2 8	7 8 3 0	80
90	13 2 18	1 8 3 10	2 4 0 2	2 19 0 22	3 14 1 14	4 9 2 6	5 4 2 26	5 19 3 18	6 15 0 10	7 10 1 2	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs. 7 11 3 4	t. c. q. lbs. 15 3 2 8	t. c. q. lbs. 22 15 1 12	t. c. q. lbs. 30 7 0 16	t. c. q. lbs. 37 18 3 20	t. c. q. lbs. 45 10 2 24	t. c. q. lbs. 53 2 2 0	t. c. q. lbs. 60 14 1 4	t. c. q. lbs. 68 6 0 8	t. c. q. lbs. 75 17 3 12	Weight.

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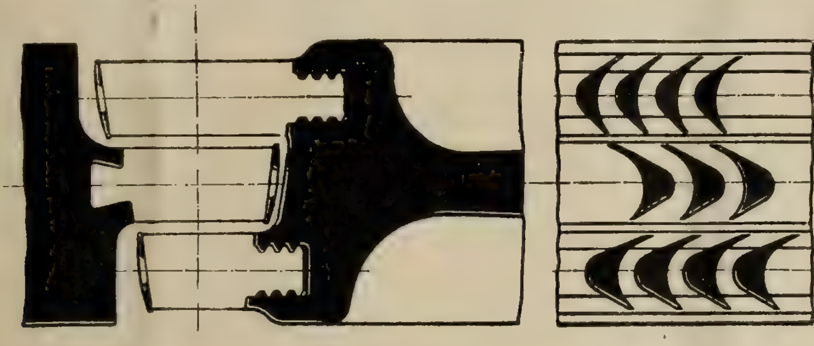
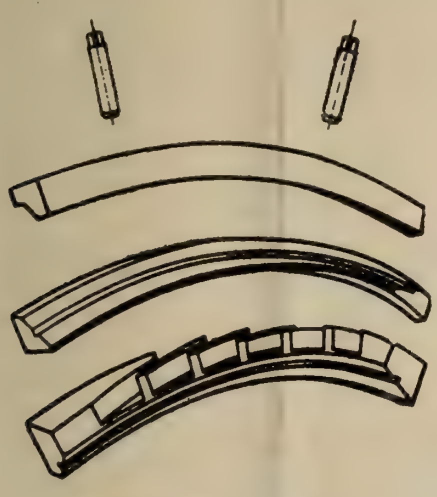
Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues

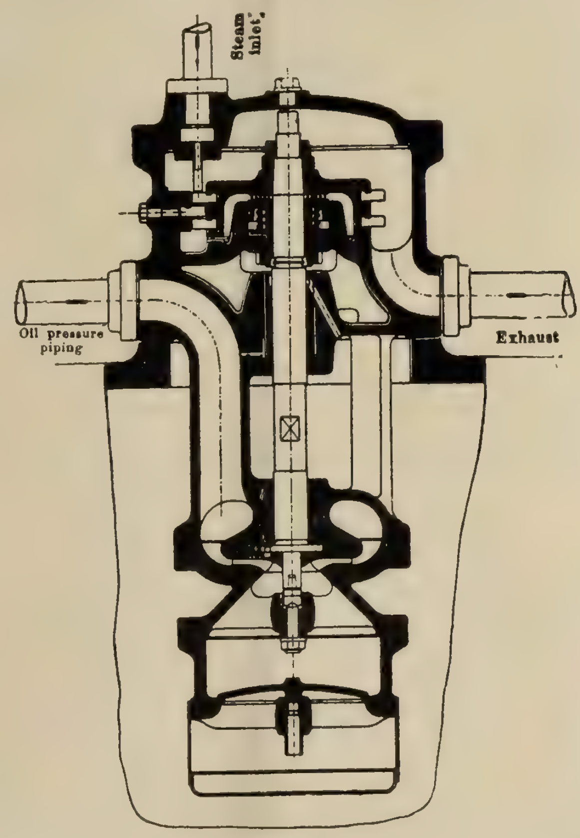
blades fit are formed with a projecting tongue, which holds the blades firmly in position. Sudden temperature variations do not, it is claimed, affect this form of fastening, and experience has shown that the system is well able to withstand the effects of superheated steam. At their outer ends the blades are secured by a coppered steel wire, which is threaded through the blades and soldered. As the high-pressure steam is dealt with by an impulse wheel, it is possible to allow ample clearance between the moving blades and casing and the guide blades and drum. All machining is very carefully carried out, and special care is taken to ensure uniform expansion of the cylinder casing. The construction of the impulse wheel will be understood from Fig. 89. The blades, which are either of bronze or steel alloy, and possessing special abrasion-resisting properties, fit into corrugated grooves on the rim of the wheel, and are spaced by means of distance pieces. The last distance piece is formed with a pin which fits into a radial hole drilled in the rim for its reception, and is riveted over on its inner side, this having been found to be a simple and efficient method of securing the blades. The construction of the nozzle segment is shown in Fig. 90 which, in conjunction with Fig. 87, is self-explanatory. The shafts of the turbine and that of the machine it drives are each supported on two bearings and, in accordance with the usual practice, the shafts are coupled together by means of a flexible coupling, so that each shaft is capable of individual adjustment, and in the event of the shafts becoming slightly out of line, due, for example, to the foundations slightly sinking, the satisfactory operation of the plant will not be impaired. On large turbines it is customary to provide the coupling with a barring device, so as to facilitate turning the rotor round for inspection and other purposes. For relatively low-speed turbines, bearings lined with white metal are used, but for high-speed machines the Parsons' sleeve type bearing is sometimes adopted. The whole of the moving parts of the governor are enclosed in a single housing, the cover of which can easily be lifted, thus giving access to all the moving parts on the removal of a few bolts. The glands at the end of the turbine are of the steam-sealed low-pressure labyrinth type, similar to those fitted to the Parsons' turbine. Oil under pressure is



STEAM TURBINES.—FIG. 89.



STEAM TURBINES.—FIG. 90.



STEAM TURBINES.—FIG. 91.

supplied to the bearings and the oil relay of the governor by means of a rotary oil pump situated beneath the governor, and is coupled to the governor shaft. For starting the turbine, however, an auxiliary oil pump is provided. This pump, which is shown in Fig. 91, is driven by means of a small steam turbine, and it delivers oil at a maximum pressure of 20 lbs. per square inch. The small turbine is of the impulse type, the impulse wheel having two rows of blades and being mounted at the upper end of the vertical pump spindle.

(To be continued.)

WORKED EXAMPLES IN APPLIED MATHEMATICS

By G. E. Gittins, B.Sc. (Lond.).

(*Continued from page 235.*)

Example 8.

Investigate the equation to the common catenary, and deduce the relations $s = c \tan \phi$, and $y = c \sec \phi$.

Solution.

The catenary is the name given to the curve assumed by a uniform cord or flexible chain loaded only with its own weight and suspended from its two ends.

From the equations, which we shall derive, many calculations may be made, and the student is advised to spend some time on this and the following examples.

In Fig. 6 consider the equilibrium of a portion O P $= s$ measured from the lowest point O. If w is the weight per unit length, then weight of O P is

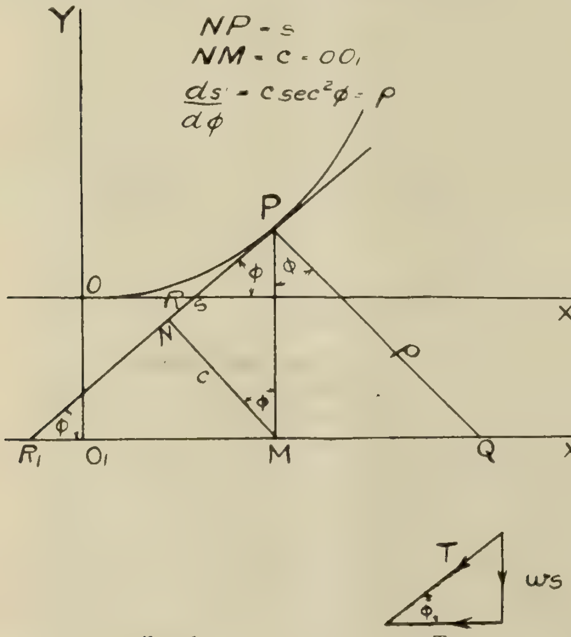


Fig. 6.

given by W $= w\,s$. At P draw a tangent to the curve meeting the axis of X in R at an angle ϕ. Let the tensile forces be T at P and T_o at O. Then from the triangle of forces we have that

$$\tan \phi = \frac{w\,s}{T_o} = \frac{d\,y}{d\,x} \text{ that is, putting } T_o = w\,c,$$

$$\frac{s}{c} = \tan \phi \text{ or } s = c \tan \phi.$$

This is known as the intrinsic equation to the catenary, and the quantity c is called the parameter. We shall show later how c may be found.

Again, if $\triangle s$ be an elementary length of the cord, then $(\triangle s)^2 = (\triangle y)^2 + (\triangle x)^2$, so that in the limit

$$\frac{d\,s}{d\,y} = \sqrt{1 + \left(\frac{d\,x}{d\,y}\right)^2}$$

$$= \sqrt{1 + \frac{c^2}{s^2}}$$

and $$\frac{d\,y}{d\,s} = \frac{s}{\sqrt{c^2 + s^2}}$$

since $$\frac{d\,y}{d\,x} = \frac{s}{c}$$

Integrating we find $y = \sqrt{c^2 + s^2} + B$ where B is some constant. Now when $y = o$, $s = o$, and therefore $B = -c$. Hence we get $y + c = \sqrt{c^2 + s^2}$ or $s^2 = y^2 + 2\,yc$ and $s = \sqrt{y^2 + 2\,yc}$, the positive value being taken since y increases with s. We have seen that $\frac{dy}{dx} = \frac{s}{c}$ and $dx = \frac{c}{s}\,dy = \frac{c\,dy}{\sqrt{y^2 + 2yc}}$

Integrating this, $x = c \log \frac{(y + c) + \sqrt{y^2 + 2yc}}{c.}$

Writing this in the exponential form

$$e^{\frac{x}{c}} = \frac{(y + c) + \sqrt{y^2 + 2yc}}{c} \qquad \text{I.}$$

Taking reciprocals,

$$e^{-\frac{x}{c}} = \frac{c}{(y + c) + \sqrt{y^2 + 2yc}}$$

Rationalizing the denominator

$$e^{-\frac{x}{c}} = \frac{c\,\{(y+c) - \sqrt{y^2 + 2yc}\}}{c^2}$$

$$= \frac{(y + c) - \sqrt{y^2 + 2yc}}{c} \qquad \text{II.}$$

From I. and II. by addition

$$e^{\frac{x}{c}} + e^{-\frac{x}{c}} = \frac{2\,(y + c)}{c}$$

$$\text{or } y + c = \frac{c\left(e^{\frac{x}{c}} + e^{-\frac{x}{c}}\right)}{2}$$

Putting $y_1 = y + c$, that is, removing the origin to O_1, the equation becomes

$$y_1 = \frac{c}{2}\left(e^{\frac{x}{c}} + e^{-\frac{x}{c}}\right)$$

Dropping the accent

$$y = c \cosh \frac{x}{c} \qquad \text{III.}$$

From I. and II. by subtraction

$$e^{\frac{x}{c}} - e^{-\frac{x}{c}} = \frac{2\sqrt{y^2 + 2yc}}{c}$$

$$= \frac{2\,s}{c}$$

$$\therefore s = \frac{c}{2}\left(e^{\frac{x}{c}} - e^{-\frac{x}{c}}\right)$$

$$= c \sinh \frac{x}{c} \qquad \text{IV.}$$

Again, since $\tan \phi = \dfrac{dy}{dx} = \sinh \dfrac{x}{c}$

and $\sec \phi = \sqrt{1 + \tan^2 \phi}$

$$= \sqrt{1 + \sinh^2 \frac{x}{c}}$$

$$= \cosh \frac{x}{c}$$

$$= \frac{y}{c}$$

therefore $y = c \sec \phi$.

Collecting the results, we have the equations—

i. $y = c \cosh \dfrac{x}{c}$.

ii. $y = c \sec \phi$.

iii. $s = c \sinh \dfrac{x}{c}$.

iv. $s = c \tan \phi$.

Also note that from the triangle of forces

$$\frac{T}{ws} = \frac{ds}{dy} : s^2 = y^2 + 2yc \text{ and } \frac{ds}{dy} = \frac{y+c}{s}.$$

$$\therefore \frac{T}{ws} = \frac{y+c}{s} \text{ and } T = w(y+c)$$

$$= w y^1$$

where y^1 is the new ordinate. The total tension at a point P is thus seen to equal the weight per unit length multiplied by the height of P above the axis of X.

(To be continued.)

RAILWAY ELECTRIC TRACTION—II.

By W. A. Barnes.

(Continued from page 318.)

Higher Schedule Speeds.

The higher schedule speed obtainable is, of course, directly attributable to the higher acceleration and retardation, which, since the electric train attains its maximum speed more quickly and can be brought to rest in a shorter time, gives a higher average speed. What this means in practice is shown in the following table, which gives the schedule before and after electrification for various services on the L. and Y. Railway:—

Section.	Steam time.	Electric time.	Per cent saving.	Schedule speed—steam. M.P.H.	Schedule speed—electric.
Manchester to Bury	32	24	25	18·4	25·7
Bury to Manchester	30	22	26·5	20·2	28·2
Liverpool & Southport	55	37	32·7	22·2	32·9

Thus, since the distance between any two places may be denoted by the time it takes to travel from one place to the other, so far as business purposes are concerned, the effect of electrifying suburban districts at least is to bring the suburbs nearer to the manufacturing and business centres, and enable the public to live in suitable residential localities without having to spend too much time in travelling. The higher schedule speed at once gives us a more frequent service, and, which is very important, with the same amount of rolling stock. It follows, of course, that if the average speed is higher the number of miles run per day is higher, and, if the trips are between two points, the number of trips per day will be greater.

For a shuttle service, such as a suburban service is, the lay-over time at terminal and turn-back stations is much less with an electric service. The loco. of a steam train must either run round his train or another loco. must be in readiness, the necessary operations required, involving the blocking of two or more roads and taking at least five minutes to execute, whereas the electric train is ready for departure as soon as it can be emptied and re-loaded.

As an instance of normal working, an electric train can discharge 1,000 passengers and be ready for departure in 1½ minutes after arrival.

The higher schedule speed and more frequent service give at once a greater capacity of existing tracks, a point of very great importance near large cities, where the problem of transporting an ever-increasing number of passengers can only be solved by increasing the number of trains. This cannot be done in many cases with steam operation except by doubling the tracks, a very costly and sometimes impossible procedure, and consequently electric traction must be resorted to, and as a result the number of passengers which can be dealt with, especially at terminal stations, is at least doubled.

It will be noted that the foregoing puts forward the case for suburban and inter-urban (with intermediate stations) traffic for which electric traction is most eminently suited, and the success which has attended the electrifications which have been carried out by the various railway companies is proved by the extensions which are in progress and projected.

The author would emphasise the fact that railway electric traction is far removed from an electrical engineering problem pure and simple.

Railway traffic departments call for a system of traffic which will meet their particular requirements and give an adequate financial return, and these conditions being fulfilled, it is immaterial to them what system is employed.

Acquaintance with Traffic and Locomotive Conditions Required.

An intimate acquaintance, acquired by actual experience, is therefore required of both traffic and locomotive conditions in order to establish successfully electric traction. This applies very particularly to both the electrical and mechanical equipment of the trains themselves. The high acceleration and deceleration required in order to obtain the high schedule speed peculiar to electric traction tell very severely on the train equipment, and unless the most robust construction is employed, and special means taken to secure the attachments of all loose parts, trouble and high maintenance costs are bound to ensue.

Well-designed Gearing Required.

The necessity of substantial and well-designed gearing, where used, is another vital point, as a badly running gear sets up a series of faults in its train. First of all, there is the loss in efficiency

due to the friction set up, the extra maintenance required, which generally entails a coach being taken out of traffic, then the vibration set up reacts detrimentally on the motor brushes and commutators, causing flashing and burning, which in turn have a bad effect on the circuit breakers and control apparatus, and on the running of the trains generally. This is a matter which has not yet been fully realised by manufacturers, unless the manufacturers chance to be the railway companies themselves, but the working conditions are so abnormal that it must be kept very plainly in view if the system is to be economical and reliable.

Comparison of Systems of Electric Traction.

The author proposes to deal with the subject by giving some description of and comparing the various systems of railway electric traction now in use. The main grouping is given in the following table:—

Systems of Electric Traction.

- Locomotives
- Motor Cars

Overhead or Live Rail

- Direct Current
  - Direct Control
  - Multiple Unit Control
    - Manual Operation High or low tension
    - Automatic operation High or low tension.
- Alternating Current
  - Single Phase
  - Three Phase

In this classification no mention is made of the methods of generating the electric power, as this is common to all—lighting power and traction. The classification is made therefore purely from a traction point of view.

Railway traffic generally may be divided up into the following classes:—

(*a*) Suburban passenger.

(*b*) Inter-urban passenger between towns up to 20 miles apart with intermediate traffic and including express trains.

(*c*) Goods where the railway has already been electrified for (*a*) and (*b*).

(*d*) Long-distance passenger and goods.

This is arranged in the order of adaptability to electric traction.

It may be stated before going further that none of the systems in the foregoing table will give all the requirements necessary to operate all the classes of traffic given above to the best advantage. There are so many factors, such as density of traffic, distance apart of stations, express traffic, long-distance traffic, goods and passenger traffic, entering into the problem and for which one or other of the systems is better adapted that it is necessary to judge each case separately in order to find the system or combination of systems which will give the best results.

Electric Locomotives or Motor Cars.

The foregoing applies very strongly with regard to the use of locomotives or motor cars. The direct or alternating-current systems are equally applicable to either, so that the choice in this case really becomes a matter of traffic and financial considerations.

Motor cars are particularly adapted for classes (*a*) and (*b*) above, and locomotives can be used to better advantage for classes (*c*) and (*d*).

(To be continued.)

LUBRICATION OF AIR COMPRESSORS.

By H. V. Conrad, M.E., Secretary, Compressed Air Society, New York.

Satisfactory lubrication of air compressor cylinders is attained by securing (1) the reduction of friction to a minimum, and (2) elimination of carbonisation of the oil as far as possible.

For the proper reduction of friction, the oil chosen should have sufficient body to sustain the weight of the moving parts, to form a seal between the piston rings and the cylinder walls, and still not absorb excessive power in the overcoming of the viscosity of the oil itself.

The objections to air cylinder oils which allow more than the very slight amount of carbonisation which appears unavoidable, are, of course, well known, but may be briefly stated for the purpose of clarifying what follows:

Carbonisation of the oil allows the accumulation of deposits of carbon which are sticky in the early stages of their formation, but hard and flinty later. Such deposits accumulate on the cylinder valves, in the cylinder passages, in the pipes, and eventually in the air receiver.

Sticking or partial closing of the valves and their consequent failure to act properly is probably the chief objection to this action from the standpoint of the efficient operation of the compressor.

Causes of Excessive Carbon.

The formation of excessive carbon deposits is apt to be due to any one or more of the following causes:

1. The ill-advised use of some oil, such as a steam cylinder oil, which easily decomposes in the heat of the air cylinder.

2. The use of oils of too great a viscosity—commonly referred to as "too heavy oils." These do not atomize readily, and, therefore, remain too long upon the hot cylinder walls, &c., thus baking down to sticky carbon deposits.

3. The use of too great quantities of oil, which has the same effect as the use of too heavy an oil as far as the carbonisation is concerned.

4. The failure to provide a proper screen over the air intake of the compressor, thus allowing free entrance of dangerous dust (especially coal dust).

The objections to this carbonisation, aside from the sticking of air valves and choking of the air passages, is the menace of fire entailed by carbon deposits. Carbon particles torn loose from them may become incandescent from causes which could not be anticipated by the compressor manufacturer. If such incandescent carbon particles should happen to come in contact with "oil vapour" given off by the lubricating oil, a fire might possibly be started whose menace would be small or large, depending upon how much carbon had been allowed to accumulate in the compressor and piping

to the receiver. If these are kept properly cleansed at all times there should never be a time of any danger.

This o vapour is given off from a lubricating oil at a cert ι n temperature called its "flash point," just as steam arises from water at a certain point.

Heat of Air Compression.

The selection of an air cylinder lubricant is, of course, governed to a considerable extent by a knowledge of cylinder temperature it must withstand. Knowing the air pressures, the corresponding temperatures are ascertained fairly accurately, as shown in Table No. 1.

This table gives the final temperature in the cylinder at the end of the compression stroke, for single stage, also for two stage (or compound) compression, when the free air entering the cylinder is 60 deg. F.

TABLE No. 1.—Cylinder Temperatures at end of Piston Stroke.

Air Compressed to	Final Temperature Single Stage.	Final Temperature Two Stage.
10 lbs. gauge	145 degrees F.	
20 lbs. gauge	207 degrees F.	
30 lbs. gauge	255 degrees F.	
40 lbs. gauge	302 degrees F.	
50 lbs. gauge	339 degrees F.	188 degrees F.
60 lbs. gauge	375 degrees F.	203 degrees F.
70 lbs. gauge	405 degrees F.	214 degrees F.
80 lbs. gauge	432 degrees F.	224 degrees F.
90 lbs. gauge	459 degrees F.	234 degrees F.
100 lbs. gauge	485 degrees F.	243 degrees F.
110 lbs. gauge	507 degrees F.	250 degrees F.
120 lbs. gauge	529 degrees F.	257 degrees F.
130 lbs. gauge	550 degrees F.	265 degrees F.
140 lbs. gauge	570 degrees F.	272 degrees F.
150 lbs. gauge	589 degrees F.	279 degrees F.
200 lbs. gauge	672 degrees F.	309 degrees F.
250 lbs. gauge	749 degrees F.	331 degrees F.

Variations from these temperatures will occur in actual practice, due to water-jacketed air cylinders and radiation, tending to lower the temperature at the higher pressures. But at, say, 50 lbs. pressure and lower, the heat is likely to be somewhat greater than given by the table, particularly if the compressor is run at high speed, and also if it is not water jacketed.

The natural inference of the reader after noting the temperatures in Table 1, is that he must select an air cylinder oil whose flash point is higher than the maximum temperature apt to be encountered within the air cylinder. As a matter of fact, this is not the case, and it need only be carefully noted that the study of the air cylinder temperatures is useful mainly in testing lubricating oils to determine their resistance against breaking down into carbon, &c. But such temperatures cannot be taken as limits establishing the highest allowable flash point for a lubricant safe to use in the air cylinders.

For average normal conditions, the cylinder lubricating oil should be a medium-bodied pure mineral oil of the highest quality, not compounded with fixed oils such as animal or vegetable, and should be carefully filtered in the final process of manufacture. Quite a range of oil composition is permissible for lubricants approved for this work, which are manufactured under the above conditions.

Paraffin Base Lubricating Oils.

Merely as a guide to aid the operator in specifying the qualities to be possessed by an air cylinder lubricant recommended for average duty, the Table No. 2 is presented.

It is suggested that those oils within the range expressed by the minimum figures be used for light duty of low-pressure and temperatures, while those expressed by maximum figures should be used for high pressures and temperatures.

It is recommended that any paraffin base lubricant intended for use in "all standard air compressors" should meet the physical tests imposed by the average range of figures given in the middle column of the above table. The above wording "standard air compressors" is to be interpreted as including the following types of machines:

(*a*) Low-pressure up to 100 lb. compressors, which may be either small-sized single-stage units, or larger sized compound machines.

(*b*) High-pressure compressors which are constructed with the proper number of stages, so that no excessive temperatures are ever reached.

In other words, this lubricant of average test figures is always recommended unless a compressor manufacturer specifies in his literature that a high flash point oil should be used to meet the conditions peculiar to his machine. It is thus obvious that it is never necessary that a lubricant should possess a flash point as high as 500 degrees, unless abnormal conditions of high temperature prevail. Such high flash point oils have an unusual tendency to produce carbon deposits.

Asphaltic Base Lubricating Oils.

This group of oils is considered separately for the reason that the lower limit of gravity stated in the above table, viz., 25 deg. baume, eliminates this entire group from consideration—which is not the intention of this article.

As a guide for the selection of suitable oil, Table No. 3 is given:

For general all round use, it is conceded that the recommendations given in Tables No. 2 and No. 3 above cover the situation as well as possible, special cases, of course, requiring investigation and special consideration before making recommendations.

Quantity of Lubricating Oils.

The quantity of lubricating oil to feed to the air cylinders of compressors cannot be stated in exact terms due to the varying viscosity of different oils, the heat of compression and the size of cylinder. It may be stated in general, however, that after the cylinders have acquired smooth and polished surfaces, the quantity should be reduced to the lowest limit to avoid the possibility of the accumulation of carbon and sooty deposits within the system due to excessive use.

The following basis of quantity given in Table No. 4 is recommended, subject to above modifications for these cylinders or equivalent sizes, operating under normal conditions.

It will, of course, be carefully noted and clearly understood that the results in the last column of Table No. 4 are based upon the assumption that under average conditions of temperature and usual range of oil viscosities, a pint of oil will contain an average of about 16,000 drops. It is, of course, understood that these figures are offered merely as an approximate guide, and that every individual must exercise his own judgment in modifying them wherever his own particular set of working conditions is unusual.

A leading authority on compressor engineering con-

tributes the following: The best way to determine the proper amount of lubrication is to take out the valves from time to time and examine the cylinder. All parts should feel that there is oil thereon. If they feel dry, the lubricators should be adjusted to feed a little more oil, whereas if oil lies in the cylinder, and its parts show excessive oil thereon, the quantity fed by the lubricators should be reduced. By thus examining the machine a few times the proper amount of oil can be determined to suit the characteristics of the particular lubricant used, and the conditions under which the machine operates." This is a better way to finally determine the quantity of oil required than by adopting without this experimenting any tabulated number of drops.

(To be continued.)

WATERFALLS AND THEIR USE.

Now that the war is over, a great deal more attention is going to be given to the utilisation of natural forces for the production of power; this seems to be especially the case in France. Here, waterfalls, mountain torrents, cascades are being examined and tested in all directions, with the view to discovering fresh sources of hydraulic power. The Government also has promised its assistance. All waterfalls with a power of more than 500 kw., or those intended for public use if they exceed 50 kw., are now subject to Government control, and will only be exploitable subject to the granting of concessions. These concessions will be granted for a period of 75 years, instead of 50 as heretofore, and the State will be interested in the working profits—that is to say, they will take a royalty upon the net profits realised. Special departments and offices are to be formed and capably directed for the utilisation of hydraulic power in France. Various proposals of a similar nature have already been submitted to the State, and have been accepted. Somewhat of a novelty in connection with these rules and regulations being drawn up is that the utilisation of the tides of the sea will be submitted to the same laws as those applying to hydraulic force obtained from ordinary water-courses or cascades.

Perhaps one of the most important and notable services of this kind in France is the great plant for supplying power to the Sud-Electrique Works at Madiere (Ariege), where the water of the cascades has been trapped and diverted into huge pipes, which pass over the crown of the cliffs at a still higher angle than that originally intended by nature, so that the height of fall is augmented, whilst the power of the water is still greatly augmented by the great compression of the torrent. This installation supplies all the power required by the works for the generation of electric current, which is distributed in the form of light, heat, and energy to a distance of many miles.

It would be well advised for engineers to devote increasing attention to the forces of nature, which are always more or less available. One never knows when another war may overtake us. In such event supplies of coal and other raw materials, more or less essential to the production of light and energy, may suddenly cut off; but it would not be at all an easy matter for an enemy country to interfere with a rushing torrent or tumbling cascade, so that it would be far easier to reckon with certainty upon the continued working of a factory run by hydraulic power than it would be in the case of an establishment the mechanical plant of which had to depend for its life and energy upon coal, wood, and other combustibles of a like nature.

CANADA'S FUEL PROBLEMS.*

Utilising Western Resources.

The fuel problem of Canada is easier to state than to solve. Broadly, it lies, first, in the distance between the coalless industrial districts of Quebec and Ontario, and the undeveloped fuel resources of Western Canada, and, secondly, in the low-grade (lignitic or sub-bituminous) character of the almost limitless coal measures of Alberta and Saskatchewan. In normal times, before the war, about half of the coal consumed in Canada was imported from the United States. During the war the increased demand for coal by the munition works of Ontario and Quebec, and the decrease in the fuel production of Nova Scotia, led to an advance in the coal imports to about 60 per cent of the total amount consumed. The pressure upon Ontario to transfer hydro-electric power to the United States in exchange for coal was described in the *Journal* of 23rd January of this year, and the steps which are being taken to develop the country's water-power resources, especially in the coal-less districts, were dealt with in some detail on 6th and 13th March. We have just received from the High Commissioner in London a pamphlet, entitled "Fuels of Western Canada and Their Efficient Utilisation," by Mr. James White, Assistant to Chairman, Deputy Head, of the Commission of Conservation, Canada. For the purposes of this paper Mr. White takes Western Canada as including Manitoba, Saskatchewan, Alberta and British Columbia, but not including the Yukon or the North-West Territories. For his figures of the actual and probable coal resources of the four Western Provinces he depends upon Dr. D. B. Dowling, Geographical Survey of Canada, who gave them in his report on the "Coalfields and Resources of Canada." The abundance of coal in the Prairie Provinces and its generally low grade are shown in the following tables:—

Actual Reserves in Millions of Metric Tons.

(Calculation based on actual thickness and extent.)

	Lignite	Lignitic or sub-bituminous	Low-carbon bituminous.
Saskatchewan	2412	—	—
Alberta	—	382,500	1,197
British Columbia	—	60	118
	2,412	382,560	1,315

	Bituminous and high-carbon bituminous	Semi-anthracite	Total
Saskatchewan	—	—	2,412
Alberta	2,027	669	†386,373
British Columbia	*23,653	—	23,831
	25,680	669	412,616

* *The Board of Trade Journal.*

PROBABLE RESERVES IN MILLIONS OF METRIC TONS.

(Approximate estimte.)

	Lignite	Lignitic or sub-bituminous	Low-carbon bituminous
Manitoba	160	—	—
Saskatchewan	57,400	—	—
Alberta	26,450	464,821	139,161
British Columbia	—	5,136	2,300
	84,010	469,957	141,461

	Bituminous and high-carbon bituminous	Semi-anthrocite	Total
Manitoba	—	—	160
Saskatchewan	—	—	57,400
Alberta	*42,022	100	673,554
British Columbia	‡42,608	—	50,044
	85,630	100	781,158

*Includes semi-anthracite.

†Total after deducting 20 million tons mined in 1911.

‡Includes 1,800 million tons of cannel.

Distribution of Coal.

In Manitoba the coal seams are thin and insignificant, but in Saskatchewan and Alberta enormous areas are known to be underlaid by coal of low grade. In Saskatchewan the actual and probable reserves, all lignite, are placed at 59,812 million tons and the coal area at over 13,000 square miles. Alberta is estimated to possess more than a million million tons, or nearly 90 per cent of the coal in all Canada. The three chief formations are known as Edmonton, Belly River and Kootenay. Over 98 per cent of the reserves in the Edmonton formation are lignitic or sub-bituminous, and the remainder is low-carbon bituminous. The Belly River formation is chiefly low-carbon bituminous. Near the Rocky Mountains comes the extensive Kootenay formation, which contains the highest grade coal (high-carbon or bituminous) found in the Prairie Provinces. In British Columbia at Crowsnest there is an area of 230 square miles, containing high-grade bituminous coal, occasionally running into anthracite. The greater portion of the coal which is mined there is converted into coke, the remainder being sold as steam coal. Some of the best steam coal on the Pacific Coast is found at Vancouver Island, where about 600 square miles are underlain by coal seams. Some 85 per cent of the British Columbian coal is bituminous, and the low-grade lignitic comprises not more than 7 per cent. The annual production of the three coal Provinces—Saskatchewan, Alberta, and British Columbia—is at present not more than 7-8 million tons, or about one-quarter of Canada's total coal consumption. The very extensive reserves of low-grade coal are as yet undeveloped, and a large part of Mr. James White's paper is devoted to a consideration of the most efficient means by which they may be utilised.

(To be continued.)

NEW STEEL WHEEL.—A Philadelphia manufacturer is producing a steel wheel for automobiles that looks very much the same as a wooden wheel. It is of built-up construction, but is simpler than the usual forms because there are but few welds and these are easy to make. It is believed that a wheel of this nature can be made as light as a wooden wheel of the same size, and be very much stronger and not subject to deterioration or damage as the wheel of less resisting material would be.

THE UTILISATION OF WASTE FUEL.

By G. W. STUBBINGS.

Increased Use of Low-grade Fuels.

One of the most noteworthy advances of recent times in the direction of the conservation of the fuel resources of the world has been the increased use of low grades of fuel that have been hitherto considered practically useless for industrial purposes. The early difficulties experienced in burning comparatively low grades of bituminous coal in steam boilers were due almost entirely to ignorance of the fundamental principles underlying the combustion of this class of coal. As these principles have been studied and appreciated by engineers, so it has been found possible to use the low grades of coal that were previously found unsuitable. So thoroughly has the theory of the combustion of bituminous coal in the furnaces of steam boilers been studied that grades of coal that even a few years ago would have been considered useless for steam-raising purposes are now successfully employed in this way.

Difficulties in Use of Bituminous Coal.

The difficulty experienced in the use of bituminous coal in boiler furnaces was not due to any lack of potential heat-producing capacity in this class of coal, but was due simply to the fact that the combustible constituents are largely composed of hydrocarbons or volatile substances. Before the combustion of bituminous coal can be initiated, these volatile constituents must not only be gasified, but also raised to the temperature of combustion. To secure this gasification, a certain amount of heat must first be supplied to the fuel, and when the hydrocarbon constituents are finally volatilised they must be mixed with the oxygen necessary for complete combustion, and finally raised to the temperature of ignition. Neglect of these two last essentials was the cause of almost all the troubles in the operation of boilers of the early types with bituminous coal. The furnaces of these boilers were frequently so designed that the volatile constituents when gasified came immediately in contact with the comparatively cool plates and tubes of the boiler, and consequently were never raised to the temperature of ignition. This resulted not only in the production of smoke, but also in the total loss of the heat value of the hydrocarbon constituents of the coal, and a consequent lowering in boiler efficiency. In modern boilers employing bituminous coal, the furnaces are so designed that the volatile constituents after gasification are mixed with the requisite quantity of air, and then drawn forward into a zone where they are raised to the temperature of combustion. Not till this combination is thoroughly initiated do the hot gases come in contact with the plates or tubes of the boiler. With boilers designed on these lines the prevention of smoke became a matter of little difficulty, and was arrived at not merely with a view to the obviating of a public nuisance, but with the object of the prevention of the waste of the heat value of the volatile portions of the coal, it being remembered that smoke consists largely of certain of these con-

stituents gasified at a comparatively low temperature.

Low-grade Fuel Difficult to Burn.

As the grade of bituminous coal gets lower, and the proportion of dust increases, the difficulty of burning it in ordinary modern furnaces becomes very great, and a limit is soon reached, at which the fuel becomes useless in this connection. The reason why this is so will be readily understood when it is considered that in the ordinary furnace the air necessary for combustion is drawn through the furnace bars and the layer of fuel upon them. When the proportion of dust in the coal becomes very great the air spaces in the layer of fuel becomes too small to allow of the passage of the air necessary for combustion, and this circumstance is aggravated by the well-known tendency of bituminous coal to cake. For this reason, the low grades of coal, such as were obtained at the mines in the processes of washing and screening were till recently unable to be utilised for steam-raising purposes. Two methods of using such grades of fuel have, however, recently been introduced with considerable success, and they may be expected to receive wide application.

Use of Coal in Pulverised Form.

The first of these processes consists in the use of coal in a pulverised form, the reduction to powder of the necessary fineness being effected by special machinery. In this form the fuel is injected into the boiler furnace by means of an air blast, this blast being so proportioned as to give the necessary oxygen for combustion. The coal, so injected, is found to burn in the same manner as a gas, the powdered form of the fuel being so conducive to complete combustion. The ash that is produced is formed in a finely-divided state, and is drawn up the chimney by the furnace blast. The combustion is under perfect control, and the operation is precisely similar to that of an oil or gas-fired furnace. The system has been found to be remarkably promising, and a locomotive has recently been built at the works of the Great Central Railway Company which will be operated with pulverised coal. With this system there are, of course, considerable capital costs and running charges in connection with the pulverising plant, but these charges will usually be more than counterbalanced by the ability to use a very cheap grade of fuel, and also by the extreme flexibility of the system. While the system using pulverised fuel would be hardly likely to be adopted for the whole of the boiler plant of a large power-reducing works, it is possible that one or two boilers so equipped would be found extremely useful in view of the ease with which the combustion can be regulated, and of the immunity of such boilers from the troubles due to variation in the quality of fuel and to the formation of clinker incident to the operation of boilers which burn their coal on furnace bars.

Further Methods of Using.

A further use for the lower grades of bituminous coal has been found in a system of scientific blending with an inferior grade of non-bituminous fuel, such as coke breeze. The majority of modern boilers are equipped with chain grates, this device consisting of an endless flexible grate, upon which the fuel is fed uniformly through a hopper, the movement of the grate being so arranged that during the time of transit of the fuel from the receiving hopper to the pit in which the ash falls, the combustion is just complete. It is not difficult to understand that in furnaces of this description, in which unmixed coke breeze is employed, the combustion of the fresh fuel has to be initiated by contact with that immediately before it, and that there is a continual risk of the combustion being interrupted. Should this take place the fire will be totally lost as soon as the last of the live fuel reaches the ash-pits. For this reason the use of unmixed coke breeze has not been found practicable in furnaces equipped with chain-grate stokers. An admixture of bituminous coal not only overcomes the difficulty referred to, but if made in the correct proportion, and by suitably-designed gear, in no war interferes with the ingress of the necessary amount of air for complete combustion. Such an admixture is made by feeding the coal and coke separately through a double hopper, the fuel passing on to the chain grate in two distinct layers, the coal being uppermost. As the coke is nearest to the grate, and the bituminous coal is in a relatively thin layer, the ingress of the air for combustion is not impeded, while the presence of the layer of bituminous coal ensures continuous combustion of the coke breeze. This method has been found to give great reliability, and a higher boiler efficiency than by the use of an intimate mixture of coke and coal slack. By the use of this apparatus it was found possible to utilise 80 per cent of the total heat value of the blended fuel, while with coal of a higher calorific value than that of the mixture, 20 per cent less of this total heat value was usefully employed, owing to the impossibility of obtaining complete combustion.

It is becoming more and more recognised that to burn the higher grades of bituminous coal in boiler furnaces involves an extensive waste of the valuable volatile constituents of this class of coal. This waste, for this can be fully utilised by complete combustion. it is to be noted, is not a waste of their heat value, this can be fully utilised by complete combustion, but is a waste of those properties which make the various volatile constituents of bituminous coal so useful for many industrial purposes. It seems, therefore, that the tendency will be to extract these constituents by distillation from all but the lowest grades of bituminous coal, such low grades being the only ones used for direct combustion.

Success of London Furnace.—With reference to the recent performance of a steel furnace, at Frodingham (Lincs.), which produced 1,103 tons 18 cwts. of mild steel in one week, we understand that this furnace was supplied and built by Wellman, Seaver and Head Ltd., of London, who are building three more furnaces of similar capacity for the same works.

The Dutch Steel Market.—So far, we learn from Amsterdam, Holland has concluded contracts with America for the supply of 40,000 tons of steel. It is hardly probable that these contracts will be further increased, as several contracts are still current with European contractors, notably in Germany. These contracts are, it is said, fully sufficient to cover Holland's present requirements of steel.

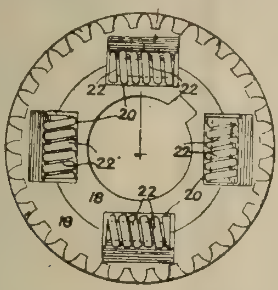
Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

INTERNAL-COMBUSTION ENGINES.

119,769.—BRITISH THOMSON-HOUSTON CO., 83, Cannon Street, London.—(General Electric Co.; Schenectady, New York, U.S.A.).—Jan. 5th, 1918.—A spur pinion is made in two parts, one 18 which is keyed to the shaft and the other 19 which surrounds the part



18 and is driven from it by compressed springs 20 which yield only when the stress reaches a certain limit. The relative movement of the two parts is limited by a pin 22 lying in the coils of the spring. The gearing is applied to driving the cam shafts of internal-combustion engines from one end of a long crank-shaft, the other end of which carries the flywheel.

STEAM-SUPERHEATERS.

119 770.—R. S. PORTHAM and J. DORNAN, 22, Billiter Street, London.—Jan. 5th, 1918.—The elements of a suprheater fitted in a water-tube boiler project diagonally between the boiler tubes and are connected to a divided header of triangular cross-section with the apex of the triangle pointing away from the boiler tubes, the elements being so arranged and connected to the header that they may be placed in position and removed by

FIG.2.

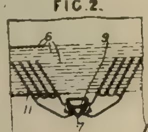
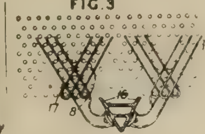


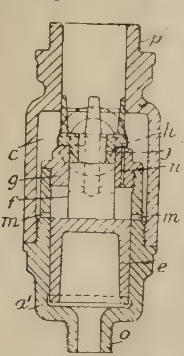
FIG.3



movement parallel to the sides of the header. **U**-tubes 11, Fig. 2, of single or multiple form arranged between rows of boiler tubes 6 are connected to the sides of a header 7, which is divided by a partition 9 parallel to its base. The legs of the **U**-tubes are arranged parallel to the sides of the header. Projections 16, Fig. 3, serving as baffles, may be formed on the header at the ends of its base. Elements 17, 18 in each group may project diagonally between the boiler tubes alternately in opposite directions. The superheater is shown fitted in a Yarrow boiler, the elements projecting horizontally between the tubes.

FLUID-PRESSURE ENGINES; TURBINES.

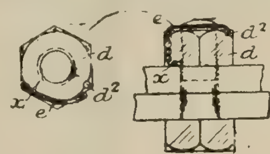
119.791.—J. E. ARMSTRONG, 15, Wolseley Gardens, Jesmond, Newcastle-on-Tyne.—Feb. 4th, 1918.—An automatic drain-valve for engine cylinders and turbine casings is constructed so that the engine may make a number of revolutions for one opening of the valve to permit the escape of the condensation water. In



the construction shown, the valve is secured at p to the engine cylinder or turbine casing and at o to the valve-chest or steam supply. The valve is provided with a head h secured to the rod f of a piston e. The valve cylinder is provided with ports m communicating with the chamber c which is provided with an outlet j, and with miniature ports n in the gland g. When the valve is forced off its seat by excesive pressure, the condensation-water enters the cylinder through ports m, n. When the pressure falls, the pressure on piston e first closes the ports m, and then the piston rises slowly, forcing the water in the cylinder $a1$ through the ports n. In a modification, the valve is provided with two seats and connections for the two ends of the cylinder or casing. In a further modification, the valve is provided also with a passage controlled by a ball valve in lieu of the ports m.

LOCKING NUTS, ETC.

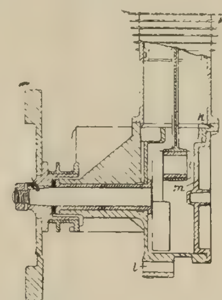
119,830.—J. F. DOWDING, 75, St. Mary's Road, Mannington, Bradford, and R. V. DOWDING, 69, Upper Tollington Park, Finsbury Park, London.—May 6th, 1918.—In means for locking together screwed parts such as bolts and nuts, the nut, etc., d carries a



wire e with one end x pointed and the other end adapted to be sprung into a hole $d2$ in the top of the nut to press the pointed end into engagement with the bolt threads and allow motion of the nut in only one direction. The nut may be completely locked by the use of a second oppositely-acting spring wire.

INTERNAL-COMBUSTION ENGINES.

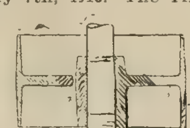
119,843.—VALVELESS TWO-STROKE ENGINE CO., and J. DUFFY, 303, Broad Street, Birmingham.—July 5th, 1918.—Crank-chambers for



two-stroke cycle engines with a single crank-disc are made in one piece and have a lateral cover m and an annular seating k for the cylinder.

PULLEYS.

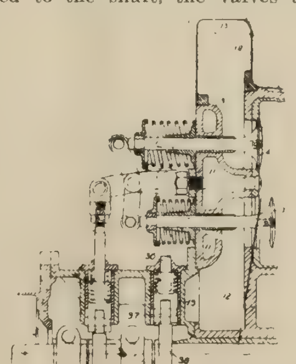
119,844.—R. B. HARTSOUGH, 2915, Knox Avenue South, Minneapolis, Minnesota, U.S.A.—July 7th, 1918.—The rim 2, web 3 and part of



the hub 4 are cast in one piece, and a loose half of the hub 7 in an opening in the web is bolted to the portion 4 to secure the pulley to the shaft.

INTERNAL-COMBUSTION ENGINES.

119,904.—W. R. FASEY, The Oaks, Holly Bush Hill, Snaresbrook, Essex.—Oct. 16th, 1917.—In engines in which the cylinders are arranged parallel to a central shaft to which the piston movements are transmitted by rollers carried by the pistons engaging a cam rib secured to the shaft, the valves are actuated by a

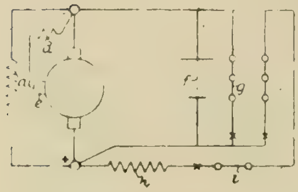


pair of cams 30, 38 on the central shaft. Preferably, in each cylinder the valves are duplicated, a pair of inlet valves 7 being actuated from the cam 38 through a roller 37, plunger 36, and bell-crank levers, and the two exhaust valves 8 being similarly controlled from the cam 30. The cylinder ends are cast with

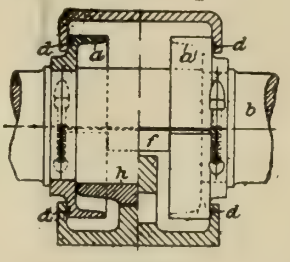
an annular member 3 containing the valve openings, an annular passage 11 for cooling water, and, with the cover 13 and casing 15, forming inlet and exhaust chambers 12, 14. The cams are so shaped that the firing and compression periods last over 75 deg. of the revolution and the induction and exhaust periods over 105 deg.

DYNAMO-ELECTRIC MACHINES.

119,942.—H. LUCAS, C. L. BREEDEN, and H. L. CAPE, of J. Lucas Ltd., Great King Street, Birmingham.—Nov. 22nd, 1917.—A self-regulating dynamo of the kind having a main shunt winding *a* and an auxiliary winding *d* connected to an intermediate brush *e* is provided with a series field-magnet winding *h* adapted to supplement the normal excitation when an extra load *i* is imposed on the machine. The battery *f* and the other part *g* of the load circuit are connected to the dynamo as shown.



Patent 119,942.



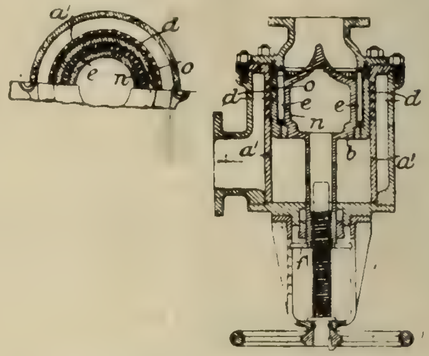
Patent 119,961

LUBRICATING.

119,961.—H. T. NEWBIGIN, 3, St. Nicholas' Buildings, Newcastle-on-Tyne.—Jan. 7th, 1918.—To lubricte journal bearings of the rocking or yielding segmental type, rings *a*, *a*1 of Z-section secured to a shaft *b* and partly enclosing the segments *h* dip into oil, which is carried up and delivered by scrapers *f* to the bearings. Leakage of oil is prevented by packing-rings *d*. The scrapers engage the inner or the outer surfaces of the rings, and may be attached to stops which prevent the segments *h* from rotating. Oil passages are formed through and between the segments *h*. A lip may be formed on the scraper to guide the oil in the required direction. In a modification applied to railway vehicle axle-boxes, the scrapers are integral with or connected to the segments.

STEAM SUPERHEATERS.

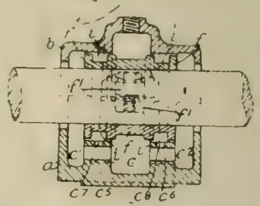
119,989.—G. RESTUCCI, 156, Nuovo Corso Garibaldi, Naples, Italy.—Mar. 12th, 1918.—Steam passes through inclined nozzles *d* in the inner wall *a*1 of a steam-jacketed cylinder and impinges against radially-curved blades *e* projecting into the annular space between the concentric walls *n*, *o* of a piston *b*, which may be moved up and down so as to close or open the nozzles according to the



quantity of steam required. A pointer *f* on the screwed spindle operating the piston indicates the number of nozzles uncovered by the piston.

BEARINGS.

120,066.—J. KING, West Bar Chambers, Boar Lane, Leeds, Yorkshire.—June 1st, 1918.—A pedestal bearing for shafts is fitted with rollers placed in two grooves *i* in a two-part sleeve *f* mounted on the shaft. The rollers run on cylindrical tracks in the pedestal *a* and its cover *b*. A central oil chamber *c* communicates by openings *c*5,



*c*6 with end chambers *c*1, *c*2, and oil gains access to the rollers through openings *c*7, *c*8. Lugs *f*1, by which the parts of the sleeve *f* are connected together, act as paddles to splash oil over the bearing surfaces. The rollers may be dispensed with, the sleeve running in contact with the pedestal and cover.

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CONTENTS.

EDITORIAL.

SENSITIVITY AND ACCURACY.

The practical man is apt to disregard the distinction between the terms sensitive and accurate as applied to measurement; further than this, he often confounds the two, assuming that because an instrument is sensitive it is therefore accurate.

To take a concrete instance, the dial indicator is sensitive, but the accuracy of its determination is dependent upon much else than its disposition to quick movement. So with a steam gauge or voltmeter, sensitivity is not proof of accuracy; indeed, the wild fluctuations of some pointer devices would make them useless for observation unless special damping arrangements were fitted to limit their unwanted movement, and so allow a rational reading. For practical purposes sensitivity can be a drawback, while for scientific determination it may be advantageous; it is the case of the contrast between the workshop and laboratory, between the scientific and the commercial. To weigh diamonds, or for quantitative chemical analysis, a balance cannot be too sensitive; to obtain the shipping weight of a case, where a pound or two is immaterial, the weighing machine of sensitive character can be a nuisance. In human connections, it by no means follows that extreme sensitivity postulates accuracy or endurance, although quick intelligence is undoubtedly a product of quick reaction to stimulus.

Getting back to more material considerations, is it possible that modern appliances for the determination of error are too sensitive, and, by reason of this, measurement is becoming too refined, and, consequently, production getting over expensive? There are cases where the finest is too coarse for the purpose in exacting precision work, but the vast bulk of engineering production is of coarse character compared with the means of determining error. There is a tendency to decry production where a few thousandths error has no practical effect, and there is undue insistence laid upon measurement rather than function in the case of mechanism for baser uses. Moreover, it is now usual to separate process by class: metal shifting is done apart from metal sizing, and the former need for accuracy in the earlier-stage machines is less important.

The days of slow-speed water cuts as a finish in the lathe are over; where high finish or great accuracy are required, this is entrusted to grinding. Hence extreme accuracy in the lathe is less important now than ever, while, owing to more sensitive appliances it get more attention.

Horse sense should be applied to accuracy, and undue and expensive refinement are conditioned by use. Rigidity is obviously of importance, but it is possible to pay too great a regard, or rather be too sensitive, on the matter of fine limits where these can be widened.

THE WAGE PROBLEM IN INDUSTRY.

By W. L. Hichens

(Chairman of Cammell Laird and Co. Ltd.).

(Continued from page 288.)

Reduction of Hours.

How is it, then, that these important factors tend to be ignored when wages increases are considered? For that they are ignored is obvious to every observer. Demands for increases of wages are of almost daily occurrence and, commonly enough, they are coupled with a claim for reduced hours or reduced prices. Wages on the railways have been increased by about £80,000,000 during the past four years,

and on the top of that the concession of an eight-hours day will add a further £20,000,000 to the wages bill. Where is the money to come from, we ask, but, like jesting Pilate, we do not pause for an answer. The next day the public is clamouring for a reduction in railway fares, and the day after acquiesces in the addition of millions of pounds a year to the cost of coal. The coal position, indeed, grows increasingly serious, for coal is the mainstay of our industrial prosperity, it is the great asset upon which our commercial fabric is based. How, then, do we stand in regard to coal? In 1887 we produced 299 tons per worker at a wage cost of £52 per head. In 1914 the output per worker had fallen to 243 tons, while the wage cost had risen to £99. In 1918, during the great national crisis, the output had shrunk still further to 224 tons per worker at a wage cost of £197.

Again, the concession of a forty-seven hour week in the engineering and shipbuilding industries means, it is calculated, an increase of 5 per cent in the cost of the finished products. And yet before the ink of the agreement is dry, before there has been an opportunity to see how the new arrangements will work, a demand is raised for a forty-four or even a thirty-hour week. Surely it is high time that we recovered our sanity, and recognised that what we are doing can only have the effect of injuring those whom we design to help, of destroying, not reconstructing industry. Surely it is clear that whatever the solution of the problem of wages in industry may be, we shall not reach it along the present road. We are merely revolving in a vicious circle, and unless we can make up our minds to cut clear of the evil traditions of the past and the profligate timidity of the present, we shall have a rude awakening.

Might v. Right.

Wages, according to political economists from Adam Smith's day onwards, are governed by the laws of supply and demand, and the price of the necessaries and conveniences of life. "What are the common wages of labour," says Adam Smith, "depends everywhere upon the contract usually made between these two parties, whose interests are by no means the same. The workmen desire to get as much, the masters to give as little as possible." Hence employers have organised themselves into associations, and workers have created trade unions, in order that they may have the necessary power to enforce their demands. The determining factor in each case has been the strength of either side, and the effective criterion of what wages ought to be has been the will of the strongest party. If employers are not strong enough to withstand a strike, if the workers have a sufficient fighting fund, wages are raised; if, on the other hand, the workers cannot hold out against unemployment and the spectre of starvation, the employers enforce their will. Strikes and lock-outs are recognised, not merely by employers and workers, but also by the Government, and, indeed, the whole community, as the proper method for settling industrial disputes; they are sanctioned by public opinion, and no alternative method has gained acceptance. And yet the theory that the only effective criterion of justice is what a man is strong enough to take and to hold, that might is right, strikes at the very roots of civilised society—indeed, of all social existence and of all religion. Might is the handmaid of right—not its master, and this must be true of all human relations, not merely of a selected few. The claim by Germany that the only criterion of her rights in relation to other nations was what she was strong enough to take and to keep, has led to the greatest war in history, and we are living in a fool's paradise if we suppose that a principle which leads to disaster as between nations will not have the same results as between the rival sections of a single community. Indeed, a community presupposes a common purpose, which is greater than the rival interests of individual groups, and unless the claims of one section are determined in the light of the good of the community as a whole, society becomes a disorganised rabble, and is resolved into an aggregation of dens of thieves.

State Intervention.

Industry is one of the last strongholds of "King Might," and even here his sway is not as unquestioned as it was. The State tends to intervene more and more, and to determine in ever-increasing measure for the common good the conditions under which industry shall be carried on. This is its legitimate function, and one by no means to be confounded with State trading, which is indeed inconsistent with the due exercise of impartial supervision in industrial matters. The development of State trading with which we are threatened will, it is to be feared, deal a shrewd blow at the authority of the Government as the final arbiter on industrial conditions, for being itself a trader it will lose its impartiality, it will become a judge in its own cause, and will think as an employer of labour, not as the representative of the community.

But although, as I have said, the State tends to intervene more and more in industrial matters, and to determine the conditions under which industry shall be carried on, its authority is still effectively disputed in the settlement of the wages problem, or, to put it more broadly, the problem of the relation between wages and profits. And indeed, so long as both employers and workers refuse to recognise the authority of the State, and claim that the profits and wages which each side respectively is strong enough to enforce are those to which they are entitled—that might is the only criterion of right—so long, too, as the general public acquiesce in, if they do not actively endorse this view, the State cannot assert its rights. Government is obviously impossible if, and in so far as the great majority refuse to be governed, and we can but drift towards the rocks until the public consciousness is awakened, remembering the while that the longer it is delayed the more rude will the awakening be.

Labour and Capital.

The wage problem in industry, which is the subject of this paper, is in essentials simple to grasp; it is, as I have said, the problem of the division of the proceeds of industry between labour and capital. How are we to ensure that neither the capitalist nor the worker gets too large a share of the products of industry? How are we to provide that one class of labour does not get too much in relation to another? How are we to secure that the consumer is not

robbed by the exaction of too heavy a toll for services rendered? How is the cake of communal wealth to be divided up fairly amongst the various claimants? The old-fashioned system of a general scramble, in which each fought for his own hand and the devil took the hindmost, has worked exceedingly ill, and even before the war signs of an approaching storm were not wanting. To-day everyone recognises that some change is necessary. We talk eloquently of co-operation; we put our trust in round-table conferences and Whitley Councils; but neither side is willing to surrender a tittle of its so-called rights—the right to keep whatever its strength enables it to acquire. No tinkering policy of compromise can bolster up this system for long, because it is fundamentally unsound. A radical change is inevitable.

(To be continued.)

BASILICA LEATHER BELTING: ITS VALUE MINUTELY EXPLAINED.

By James Scott.

The importance of procuring the best possible grade and quality of leather belting for the driving of various classes of machinery ought to be so obvious as not to need emphasis, yet there is plenty of evidence that in many quarters more attention should be given to this particular subject, upon which the smooth and straight running of wheels so largely depends.

We have to consider not only the conduct of the belt in relation to the mechanism with which it engages, but also its own condition and power. Although all kinds of leather used for this purpose are very much alike in fundamental structure, the modifications to which they may be submitted so alter the formation and condition of their minute features, that quite a large number of variations are obtainable.

It will facilitate the proper understanding of the subject if I briefly outline the usual treatment of an ox hide: When existing as skin on the animal's body, it consists primarily of an outer layer, or epidermis, of horny, scaly, bloodless, and nerveless substance. Beneath this portion, and merging gradually into it, is the corium, or true skin, which is composed of multitudes of bundles of strong, slender fibres of connective tissue, among and between which pass bloodvessels and nerves, etc. Hairs pass through the epidermis, and into the corium, their bulbs or roots and adjacent parts being enclosed by membrane of the same character as the skin.

There is no need to enter deeper into the physiological details for our present purpose.

For the preparation of leather it is desirable that all the epidermis and hair is removed as well as the remnants of fleshy tissue upon the underside of the skin.

Generally, the skin is soaked in a bath of caustic lime for a suitable period. This process has the effect of loosening the hairs, softening the epidermis, and dissolving away the cementing fluid from between the fibrous bundles, thereby enabling the subsequent hide to become quite pliable. After this, soaking and cleansing to neutralise and eliminate the lime is done. Then the hide has to be scraped on both sides to free it of extraneous matters.

A high degree of skill is required while the epidermis is being dislodged, because at its bottom, immediately above and in contact with the fibrous portion, is the grain layer, about which few people know very much.

In handling a piece of leather, it is plain that one surface is speckled and somewhat smooth, whereas the other is rough and shreddy. The first-named represents the outer side of the skin (after the removal of the epidermis), and the second the inner side where it has been stripped from the flesh. Now, the grain surface, which is technically known as the hyaline or glassy layer, is distinct from the remainder. It is continuous and unbroken in a plane direction, but is occupied by rugosities (*i.e.*, slight mounds), depressions, and so on, besides tiny orifices through which hairs have previously penetrated. It is really a flat layer superimposed upon the underpart, which is made up of interlacing fibre bundles or tufts, loosely attached together, and bending in every direction. This is the connective tissue, and it is more open in the middle area than elsewhere. That is to say, the fibres are more densely packed together where they approach the grain layer, and at the bottom, where they once joined the flesh, the intervening remainder being rather sponge-like in structure, owing to the intricate crossing and looping of the fibres. The grain layer is buff coloured, whereas the fibres underneath are white, or nearly so. There is, however, a gradual change from surface to middle hue, because the fibres which touch the grain layer are slightly impregnated with the same products which give it its characteristic aspect. On the flesh-surface, too, the bloodstained fibres have intermingled with the others and imparted some of their iron content thereto. If this grain is scraped off, the white or pale-tinted fibres underneath will become visible. It is on account of the wearing away of this layer that belts become defective.

The chemical composition of the leather need not bother us. The basis of the hornier parts is keratin, a substance which is immune from attack by corrosive agents. Most of the fibres can be changed into gelatin by long boiling in water. All parts of the skin are, of course, derivatives of the blood, albumen, lymph, and so on, supplied thereto by the richly-laden muscles underneath; but however valuable these items are during life they are useless so far as leather is concerned, and the retention of any of them would be responsible for the development of putrefaction.

Currying is the impregnation of the leather with preservative, and otherwise beneficial, oils and fats.

All kinds of substances, including egg-yolk, sheep's brains, and waxes have been used to permeate hide, and convert it into leather.

The main facts to be borne in mind is that leather is practically indestructible, except by means of abrasion, which slowly divides the fibres, etc.

Coming now to a more direct consideration of our subject we learn that the belting of the Basilica Manufacturing Co. Ltd., Hencroft Works, Leek, Staffordshire, is specially prepared from the best selected ox hides, the butts only being used. Butts,

by the way, are hides from which the necks, shoulders, and thinner parts of the belly have been trimmed off.

Raw hide, properly manipulated, has proved to be far better and stronger than oak-tanned hide, which is apt to have its fibres too harsh, dry, and hard, therefore becoming liable to turn brittle.

It is quite customary to so deal with skins that the leather they give is swollen or plumped. While this condition may be all right for some applications, it is not so for others. It has a false appearance value, and the grain and fibres are likely to disintegrate more rapidly than they should do.

On the other hand, the special methods adopted for the making of Basilica belting consolidates the fibres, so that the leather is thinner than the ordinary kinds, and actually is improved in many ways in consequence. It gains in strength, durability, and every other quality required.

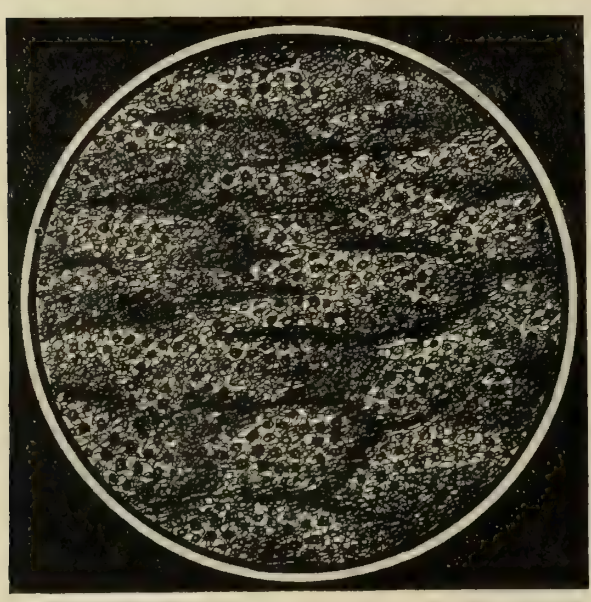


FIG. 1.

One twenty-fourth inch of the grain surface of Basilica Leather Belting, in top view, magnified. The rugosities and hollows grip and suck the metal.

It is claimed that Basilica belting transmits 30 per cent more power than, and lasts twice as long as, common varieties, owing to its non-slip nature.

Technical figures bearing on the subject can be obtained from the manufacturers, and are well worth noting.

The compressed fibres withstand fumes, vapours, steam, and prolonged work, even when running simultaneously over wheels ranging from diameters of 8 ft. down to 4 in. or 5 in.

Upon magnifying the grain surface of Basilica belting it is disclosed as shown in Fig. 1, ridges and hollows being strikingly visible. The substance is minutely honeycombed, the spaces indicating cells. In use these ridges press upon the pulleys, thereby gripping them, and at the same time the intermediate hollows serve as a number of suckers and help the grasping action. As they leave the wheels, the ridges resume their former state intact, and do not become shredded, as the fibres themselves would do in similar circumstances.

If the leather is bent with this smooth side inwards (and this is how it lies over the wheels), these ridges can be distinctly seen in bulk. By rubbing the

FIG. 2.

One twenty-fourth inch of Basilica Leather Belting, in side view, magnified ; showing the edge of the grain layer blended into the compact fibrous layer beneath.

thumb over the grain surface the gripping tendency can be well felt.

In Fig. 2 is shown an edge view of Basilica belting in which can be seen the side section of the ridges and their adjoining tightened-up fibres.

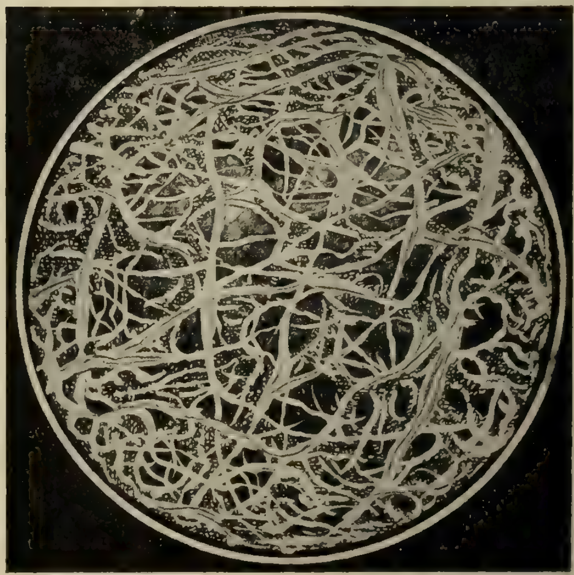


FIG. 3.

One twenty-fourth inch of the Basilica Leather Belting, in side view, magnified ; showing the middle, fibrous, meshed portions.

In Fig. 3 is shown a similar view of the middle area, plainly depicting the comparatively open mesh-like formation. The fibres are resilient, and pressure

on the wheels closes the spaces, and they afterwards expand as the leather travels onward. The incorporated oil assists in this direction, the whole belt displaying remarkable suppleness.

In life these cavities have been occupied by contents of various kinds, the retention of which would spoil the operations. The latticed result enables a belt to bend to extreme limits without cracking. As the fibres are squeezed against one another they behave as a pad for the grain surface, which curves neatly instead of splitting, as it would do in the event of the leather being too dense.

The rapidity of movement during the use of belting does not allow the reasons for gripping or slackness to be fathomed; but the reader who will carefully study the microscopic structure and responses of this material should be in a position to understand the value of the many features enumerated.

ECONOMIES IN THE GENERATION AND USE OF STEAM.

By Sidney F. Walker, R.N., M.I.E.E., M.I.M.E.

(*Continued from page 313.*)

A matter that has been much discussed in connection with steam condensers has been the form. The point mentioned previously, the bad effect of allowing the condensate to fall over the colder tubes at the bottom is challenged by some condenser makers, notably by Messrs. Weir. Some makers still prefer to keep to the old cylindrical form, because of its greater strength, greater simplicity of construction, and therefore cheaper first cost. Other makers, notably Messrs. Weir, the Contraflo Co., and Messrs. Mirrlees Watson, have adopted a pear-shaped section, the point of the pear being at the bottom. The idea underlying this form is, it is claimed, the velocity of the steam is maintained constant throughout its flow through the condenser. It will be remembered that the weight of steam is gradually diminishing as it passes through the condenser. In particular, a large proportion of the condensation takes place near the entrance of the exhaust steam, and in any case the weight is becoming less, and the pressure less as the exhaust steam entry port is receded from. The method of dividing up the condenser tubes also varies. Messrs. Weir prefer not to divide them at all; other firms divide them into banks, and the Contraflo Company divide them into wedge shaped forms, while other firms divide them horizontally. As usual there is a great deal to be said for and against all forms. All are methods to assist in accomplishing more easily what has been outlined above, the separation of the air and gases from the condensate, and the maintenance of the temperature of the condensate as near that of the steam from which it was formed as possible. There is a great difference of opinion also as to the most suitable points in the condenser from which to extract the air and gases. In all forms, both of modern and old-type condensers, the condensate is drawn off from the lowest point, the different sections where the condenser is divided being arranged to drain to the bottom of the condenser. While the majority of makers prefer to fix the air port a little higher up, some firms still fix it at the bottom.

Before leaving this part of the subject one other important matter should be mentioned, the possibility of electrolytic action in the condenser tubes, particularly in sea-going steamers where sea water is employed as the circulating water. The condenser tubes, it will be remembered, are of brass, or some special composition somewhat in the nature of brass, while the containing vessel, and sometimes the tube plates, may be of iron or steel. Any electrolytic action due to the galvanic couple formed by these metals and sea water, or sea water containing other salts, would lead to the eating away of the iron or steel. It is found however, that the brass tends to disintegrate, and this may be due to stray electric currents finding their way into the condensater. If anything of the kind is expected careful electrical tests should be made, and the condenser insulated electrically as far as possible.

The Evaporative Surface Condenser.

This form of condenser has not found too much favour up to the present, but is making steady headway. It appears to the writer, that if properly constructed and properly looked after, it should prove far more economical, in the fullest sense of the term than either of the other forms. The cooling effect with this form of condenser is obtained from the evaporation of the cooling water itself, and as each pound of water that evaporates requires to absorb 1,000 B.Th.U. to enable it to do so, it will be evident that it should be more economical in the quantity of water required to be circulated, and in the power required to pump the water than any other form of condenser. In the latest forms of evaporative condenser the condensate formed inside each tube is immediately drained off through a central tube to a receiver, from which it can be extracted by any of the forms of pump that have been described. It is claimed that the air and uncondensable gases tend to flow upwards into the upper tubes of the condenser, a natural separation being affected similar to that which is claimed to take place in the tank of the Le Blanc apparatus. The gases can, of course, be exhausted from the upper tubes by a dry air pump.

The condenser consists of a number of comparatively large tubes, or pipes usually having gills fixed on their peripheries. The pipes are fixed vertically one above the other and connected to headers at each end, the whole arrangement being placed on the top of a building, the side of a building, or wherever it will be exposed to a current of air from the prevailing wind. In one form of the condenser the stack of tubes is enclosed inside a casing, and a current of air is forced over the tubes meeting the current of water flowing downwards, the air being forced up by means of a fan. The water, with this apparatus also, flows in a closed circuit from a tank to a perforated tube, or tubes, above each vertical bank of condenser tubes. It drips down from the perforated pipe over the outside of all the tubes into a trough at the bottom from which it runs into the tank, and is pumped up again to the perforated tube at the top. There is a supply of water to the tank usually controlled by a ball valve, which allows sufficient water to run into the tank to make up for that which is evaporated.

It is claimed that the quantity of water evaporated does not exceed two-thirds in weight of that of the

steam condensed under full load conditions; and that the circulating water required is only 10 lbs.per pound of steam condensed; while, as is well known, all other forms of condenser require from 30 lbs. per pound of steam upwards. It should be mentioned also that cooling water of comparatively high temperature, does not affect the efficiency of the plant, usually the effect would be beneficial, as evaporation would take place more readily.

The writer understands that one reason for the evaporative condenser not having found favour has been the difficulty of preventing leakage. He understands, however, that in the latest modern forms of this apparatus, the improvement that has taken place in all kinds of engineering work has been followed, and that this difficulty has been overcome.

Evaporative condensers are being increasingly used in cold storage work in consequence of their greater economy and efficiency. The condenser is a very important part of all refrigerating plant.

A surface condenser that has been introduced in America is of considerable interest, because the usual arrangement is reversed. In place of the steam entering at the top of the condenser chamber, and the cooling water at the bottom, the steam enters at the bottom and the cooling water at the top. The counter current principle is maintained, it will be noted, and it is claimed that the possibility of the condensate being cooled by falling over the colder tubes is obviated. The condensate is withdrawn from the bottom of the chamber, and all the water formed by condensation flows downward over the hotter and hotter tubes, right to the bottom. The air, and uncondensable gases, it is claimed, naturally tend to rise to the top of the condenser, and are drawn off from there by a dry air pump.

Firing Boilers by Gas.

As this subject has been discussed a good deal of late, the writer has thought well to go into the matter and examine it carefully in all its bearings before passing on to the economies in the use of steam. In the past gas has scored very heavily in its competition with steam. The introduction of the gas engine was a great boon to small factories, where a small steam boiler and a small steam engine had previously been employed, and where the works were entirely dependent for their start in the morning upon the man who looked after the boiler and engine being there in good time to get steam up. The gas engine has steadily progressed, steadily increasing in size, and continually displacing steam plant; and its progress has been largely assisted by the development of the use of blast-furnace and coke-oven gases. Just before the war a halt had been called in its triumphant progress. It had been found impossible to construct a single gas engine cylinder to furnish more than 2,000 H.P., owing to the difficulty of cooling the increased thickness of the cylinder walls. On the other hand, steam turbines had been constructed to furnish 50,000 kilowatts, say, 66,000 H.P.; and there is no reason to suppose that the limit had been reached. If the super-power stations call for units of 75,000 or 100,000 kilowatts, there is every reason to suppose that designers and makers of turbines will be able to meet the demand. As in the future power is to be supplied almost entirely from super-power stations, this means that the gas engine will be entirely out of the running, unless some new discovery is made enabling either larger cylinders to be constructed, or gas turbines may be developed. Meanwhile, there is an enormous amount of gas available, at a very low cost. For every ton of pig iron delivered from the blast furnace there is a large volume of gas available for power use after the requirements of the hot-blast stoves for heating the air blast have been met; and there is every possibility that improvements in the methods of heating the air for the furnace will lead to a larger proportion being available for power. At the present time, approximately half the gas coming through the " downcomer " is available, but up to the present the writer believes no attempt has been made to economise in the matter of the heat taken from the gas for the air blast. The gas was obtained for nothing, and its use for heating the air marked a distinct economy in blast furnace practice in itself, and there has been no inducement to carry the matter any further. Also, the gas coming from the downcomer is found to be very variable in composition, and therefore in calorific value. It is more than probable that when the power question is seriously grappled with steps will be taken to neutralise this. With coke-oven gas, too, the tendency is for more and more gas to be available for power or light, because more coke ovens are being adapted to modern methods. It is also probable that further improvements will be introduced in the methods of heating the ovens, so that more than the 45 per cent to 50 per cent of the total gas given off by the coking coal will be available for outside use. In addition to these sources of gas, it has been seriously proposed that all coal shall be burnt in gas producers, the gas being employed for firing boilers. It will be remembered also that the late Sir William Ramsey suggested and argued repeatedly in favour of his suggestion, that the coal should be burnt entirely to gas and ash in its bed in the earth's crust. To the writer, the idea appears most unpractical, but one can conceive conditions under which it might be carried out. He understands that Sir Hugh Bell, the chairman of Messrs. Bell Bros., of Middlesbrough, placed a coal-pit at Sir William's disposal to enable him to try out his idea. Up to the present no report of any satisfactory result has been made public. There is a great deal to be said, however, for the consumption in gas producers of some portions of the coal seams that are not suitable for use in the furnaces of steam boilers, or in fire grates of any kind. In addition to this, makers of gas producers have succeeded in consuming every kind of waste containing carbon in their apparatus, and producing gas from it that is being used in different parts of the world for driving gas engines. Bagasse, the husk of sugar canes, the shells of cocoanuts, peat of all kinds, the refuse from various plants that grow where coal is not available, even dung, have been employed, and are being used to furnish gas for power and light.

This means that there should be a very large quantity of gas available from the consumption of what is now wasted, and the use of this gas should make for economy if it can be employed in the great power stations of the future. It will be remembered that it has been shown, by the Mond company and others, that gas can be piped quite successfully over long

distances, and can then be used for power or other purposes, so that the refuse could either be transported to the power station and consumed there in producer furnaces, or the furnaces might be erected where the refuse is made, and the gas piped to the power station.

(*To be continued.*)

SOLENOID BRAKES.

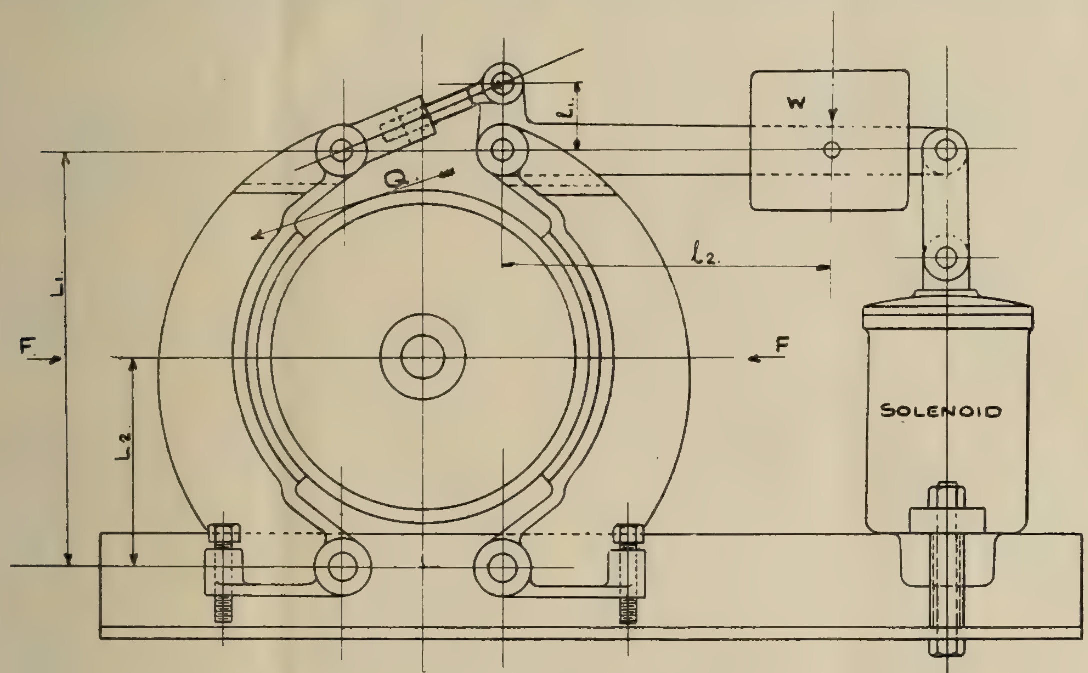
In concluding this series of articles on crane brakes, the author deals with the solenoid brake, without reference to the electrical considerations, which are a separate issue. This type of brake is universally used for all classes of cranes, hoists, and winches, and supersedes the old magnetic brake which was introduced when first electric power was applied to hoisting machinery. Its chief advantages over the the weight and overcome the friction in the various joints.

Solenoids.

Solenoids are usually standardised and stocked in three or four sizes to give, say, 10 lbs., 20 lbs., 40 lbs. and 60 lbs. pull. Care should be taken in selecting the size that the coil will give the required pull when lifting light loads; at the same time it should not lift too soon, or the load will overhaul the gear when lifting to the full capacity of the crane. A dashpot should be fitted to prevent hammering when the gear is suddenly put in and out of action.

Action of Brakes.

The weight w applies a pressure on the periphery of the drum which must be sufficient to create a resistance equal to or greater than the effort Q set up by the reaction of the load. When the gear is started up in either the hoisting or lowering direction, the solenoid, which being connected electri-



Solenoid Brakes.—Fig. 1.

latter are a longer range of movement of the plunger and compactness.

Type.

The solenoid brake may be of the clamp or band type, but preference is generally given to the former for the reason that it relieves itself from the drum better than the band type. Both are usually shod with leather or Ferodo, and the pressure is applied by springs or weights. Fig. 1 shows a brake of the clamp type; the clamps are hinged on fulcrum pins carried in an angle frame, and one is fitted at the top with a lever which is connected to the other by means of a turn-buckle for adjustment. The pressure is applied by a weight fixed on the end of the lever, which is sufficiently long to give the required purchase. The clamps are provided with bosses and set screws capable of adjustment, so that movement is imparted to both and the brake is properly relieved. The solenoid is coupled to the brake lever at the extreme end, and is powerful enough to lift cally with the motor either in series or shunted, will come into action and lift the weight w, thus relieving the brake. As soon as the motor is stopped the solenoid releases the weight and the brake again takes hold.

Design.

If the solenoid brake is intended to act as a secondary to a mechanical brake, it is not necessary that it should be capable of holding the load. Most crane builders make it so, however, as a safeguard in the event of the mechanical brake failing. If it is intended for use solely and independently as a load brake, it must be designed as such, and must be powerful enough to hold the load in all circumstances.

In the case of the mechanical brake, the braking effort is proportional to the load, *i.e.*, if the reaction of the load is increased the braking effort is increased in virtue of its automatic action. With the solenoid brake the case is different; the braking effort is

obtained from a separate source, and is constant; therefore it is necessary to make a more careful study of the dynamics of the load and machinery.

K.E. of Load.

Let W = the load on the hook in pounds,
v = maximum velocity of lowering in feet,
h = space in which load must be brought to rest in feet,
P = resulting pull on periphery of barrel, assuming purchase in blocks 2 to 1,

then

$$\frac{W v^2}{2 g} = 2 P h$$

and

$$P = \frac{W v^2}{g h}$$

K.E. of Machinery.

The kinetic energy in the heavy rotating parts must also be taken into account. These consist of the barrel and barrel wheel, the remainder being negligible.

Let B = weight of barrel in pounds,
Y = radius of gyration of barrel in feet,
C = weight of barrel wheel in pounds,
Z = radius of gyration of barrel wheel in feet,
p = resulting pull on periphery of barrel,
r = revolutions of barrel per second,

then

$$\text{total K E} = \frac{B\,(2\,\pi\,Y\,r)^2}{2\,\delta_2} + \frac{C\,(2\,\pi\,Z\,r)^2}{2\,\delta_2}$$

and assuming purchase in blocks 2 to 1, as before, then

$$p = \frac{\frac{B\,(2\,\pi\,Y\,r)^2}{2\,\delta_2} + \frac{C\,(2\,\pi\,Z\,r)^2}{2\,\delta_2}}{2\,h}$$

The total tangential pull on the periphery of the barrel in arresting the load in a distance in feet is $P + p$, and, having solved these, we can now find Q, the required effort at the brake drum.

Using the original formulæ for finding Q,

$$Q = \frac{P + p}{r}\,\mu_1 = \frac{P + p}{r}\left(2 - \frac{1}{\mu}\right)$$

Having found Q, we can find w, the weight required for the brake lever.

Let F = the force exerted by each clip on the drum,
c = the coefficient of friction between the surfaces,

then

$$\frac{Q}{c} = 2\text{ F and F} = \frac{Q}{2\,c}.$$

Using the notation shown in Fig. 1,

$$F\,L_2 = \frac{w\,l_2}{l_1}\,L_1$$

and

$$w = F\,\frac{L_2\,l_1}{L_1\,l_2} = \frac{Q}{2\,c}\;\frac{L_2\,l_1}{L_1\,l_2}.$$

If h is made reasonably small in the first formula, there is no need to make any allowance on the calculated value of w. It is fairly consistent with practice to assume a lowering speed of double the normal hoisting speed, and a good figure for h is 6 in. to 12 in.

A NEW THEORY OF PLATE SPRINGS.

By DAVID LANDAU AND PERCY H. PARR.

(*Continued from page 328.*)

LET us consider, for example, Fig. 10; this is the same as Fig. 3, with the exception that the short leaf is tapered in the plane of the width (for illustrative convenience only we have shown the most simple taper). Now, it is clear that with any given load placed on the end of the short leaf, it will deflect more than it would if it were not tapered. This is a simple and obvious fact which does not seem to require a formal proof but which is of the greatest importance. In other words, the effect of tapering the end of a leaf is to make that leaf, as a whole, more flexible; also, since the leaf still has the same section at the point of maximum stress, namely at the point of encastrèment, the safe load that may be placed thereon still remains W_1, although this load will cause a greater deflection of the short leaf than in the case of a non-tapered leaf. This being granted, we may next consider the effects on the leaf above.

Since the load, W_1, on the end of the short leaf (for convenience it may be taken as the load producing the maximum allowed stress in that leaf) can only come from the pressure of the plate above on it, it follows therefore that the plate above must also deflect a greater distance when the bottom plate is tapered than when it is not.

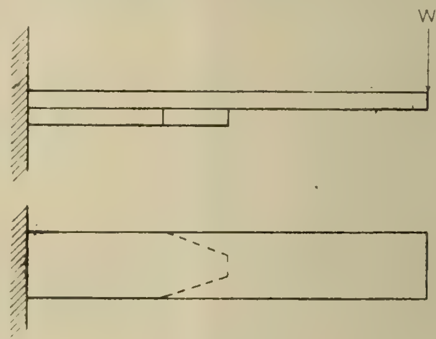


FIG 10.

But, in order to obtain this greater deflection of the plate above we must place a load, W_2, on it which is greater than it was in the cases of the non-tapered bottom leaf shown in Figs. 8 and 9.

Some readers may take exception to the statement that the load W_2 becomes greater in this case; their judgment is not to be questioned here, but we ask them to withhold any contrary opinion until we give the more rigid proof; we ask them to accept, provisionally, our statement that W_2 is greater when the bottom plate, No. 1, is tapered than when it is not. On this basis we will continue further.

Assuming then that W_2 has now become greater than 4/5 W_1 (the value found in our first paper) we see that we have the apparently curious result that when we taper the end of the leaf below we can increase the safe load on the leaf above, and, of course, on the spring as a whole—a result that would hardly be expected, much less looked for. This concludes, briefly, the "word-picture" of the principles in question and of which the formal proofs will be given shortly.

To avoid misunderstanding in future expositions concerning tapered-end leaf springs it is to be understood that we use the word taper in its most general sense,

except in cases where it is specifically given a limited meaning. A taper, straight or curved, in width only, as in Fig. 10, or a taper in thickness, or any combination of the two, may be assumed to apply with equal force to the discussion.

It seems to us, as the result of our experience of teaching some of these principles to others, that clarity of the mathematical exposition may be gained, and greater confidence placed in the formal reasoning if we place some additional physical illustrations before the reader. Realising, as we do, the difficulties we had in the earlier years of this investigation, we are prone to expand somewhat our illustrations in order to avoid later dilation. The reader who is so fortunate as to have already obtained a clear mental grasp of our general ideas may skip the next few paragraphs.

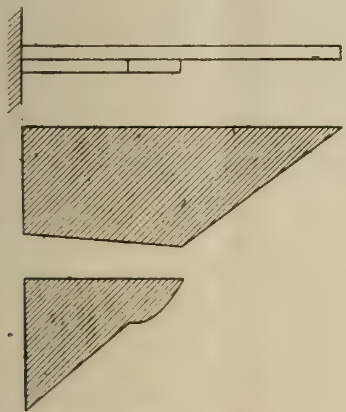


FIG. 11.

Consider again Fig. 10; we have stated that W_2, in this case, is greater than the corresponding W_2 of Fig. 3 for the same value of W_1; suppose then that W_2 instead of being equal to $4/5 W_1$, as was the case for Fig. 3, is now equal to, say $4/10 W_1$, and let us see what happens to the stress distribution in the two plates. The result of this assumption is shown in Fig. 11, which is to the same scale as Fig. 8, in which we showed the stress distribution for the two-leaf spring of Fig. 3. The most importance result is that the stress in the main, or master leaf, has increased, by about 6 per cent on an average and so the mental in this leaf, which is still not stressed as high as that in the short leaf, is, however, being used to much greater advantage. The stress in the short leaf has been increased slightly, in the tapered part, but the difference here is not of great account; at the same time, it is all in the direction of greater load capacity per unit weight of spring; the weight of metal has been reduced, and that which has been left is utilised to greater advantage. The whole effect then may be said to be: If, in any spring, the "plate below" is tapered in any of the well-known ways, the stress in the "plate above" is increased and, therefore, within certain limits (to be defined later), the safe load on the spring as a whole may be increased.

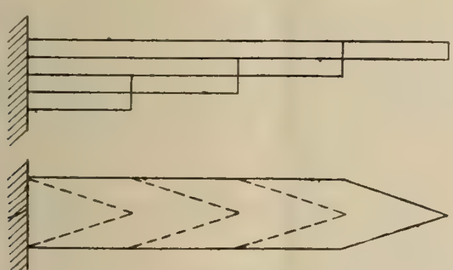


FIG. 12.

Our investigations of the history of the theory of plate springs given in our first paper indicate that this very important effect (tapering) has never seriously been considered by any previous investigators.

We have used the terms "plate below" and "plate above;" it seems opportune to define here the sense in which we always use these terms before proceeding further. Any plate in a spring may be taken as the datum plate for particular purposes, in which case any shorter plate may be called the "plate below" and any longer plate, the "plate above": thus in a two-plate spring, the short plate is the "plate below" and the long or master plate, the "plate above."

We have already seen that with any plate spring composed of non-tapered plates of equal cross section, the stresses in the upper plates are less than those in the lower ones, and we have just shown that the effect of tapering the ends of the lower leaves is to increase the stresses in the upper ones. The question naturally follows—is it possible so to arrange the tapers that the reactions and stresses shall all be equal? The answer is in the affirmative. A spring having these characteristics can be constructed, and is shown in Fig. 12, which really is none other than that of Fig. A of our historical introduction. This is the special spring regarding which all of the old and ordinary formulæ are based, but it is never, or at least very rarely, found in practice. It will be shown later that such a spring made of equal thickness plates and in which the tapers are so made that the moment of inertia is everywhere proportional to the bending moment in the overlap or step, has equal reactions and the stresses are everywhere the same. Theoretically this should be the ideal spring, as it would then carry a load directly proportional to the number of plates; there are other modifying circumstances, however, which will be duly discussed, that prohibit such springs from carrying loads directly proportional to the number of leaves, and such springs, in consequence, are not to be found in general use.

Before closing the general description of the physical effects of tapering the ends of the leaves we must push the question a little further and ask: what is the effect of tapering the plates too much? The answer is, as we shall prove in due course, that the reactions go on increasing and, after a certain limiting amount of taper, any further tapering will cause the stresses to be greater in the upper leaves than in the lower ones. Since it is usually, from a practical point of view, most important that the master leaf of a spring should not be the first one to fracture, it follows that an excessive amount of tapering is most objectionable. It appears also that the exact details of the tapering are of the utmost importance, and while this is a question which has been altogether neglected from the scientific point of view up to the present, it is necessary to study it with the greatest care in order to obtain the best springs, and it is mainly through the study of this major detail that we have been able to obtain some of the results indicated in our first paper.

The physical illustrations of the effects of tapering the ends of the leaves can no longer be dealt with by

exemplifications and analogy; they would soon grow so complex as to become unintelligible. The following mathematical exposition will clarify the situation.

(To be continued.)

RAILWAY ELECTRIC TRACTION.

By W. A. Barnes.

(Concluded from page 334.)

Motor Car Trains.

The advantages of motor-car trains over steam trains, especially at terminal and turn-back stations, have already been dealt with, and these advantages hold good to a large extent over trains drawn by electric locomotives. Further advantages are the greater ease with which a motor-car train can be strengthened or reduced since each car is an independent unit, and the greater freedom from breakdown due to the larger number of motors, etc., in use. For goods traffic, however, electric locomotives must be used, as it would be quite out of the question to equip individual wagons with electric gear, and though long distance express passenger traffic could be operated by motor cars, it would probably be better to use electric locomotives, especially for through traffic running over more than one company's system. In the latter case, since it will be some considerable time before standardisation is arrived at, it is quite conceivable that one company might use an overhead conductor, another top contact live rail, and another a side contact, and some difficulty, apart from expense, would be found in equipping motor coaches to run on all the systems, to say nothing of the different voltages or of direct or alternating current being in use. These difficulties could be solved by the use of locomotives, one being detached at the terminal station of its system, and the train itself, which would consist of ordinary stock, taken forward by another equipped for its own particular system.

Direct-current Systems.

Direct Control.—With this system the whole of the motors of the train are directly controlled by a main controller at each end of the train, the actual contacts or switches for cutting out the resistances, feeding current to the motors, and changing the motors from series to parallel being in the controller itself and operated directly by the motorman.

An instance of this applied to a single car is the ordinary street tram. The original trains supplied for the L. and Y. Railway Co.'s Liverpool and Southport electrification in 1904, and which are still in constant and successful use, are examples of this system. The trains, which consist of three, four, or five cars, have a motor car at each end with a controller, the intermediate cars being made up of non-motor cars or trailers.

The chief merit of this system is its simplicity, the wiring being all main wiring and therefore at a minimum, and for voltages which can be safely handled in a controller, say up to 750, and with trains which do not require frequent strengthening or reducing, it is a very satisfactory system to use. Its disadvantage is that in cases where, in order to meet with traffic conditions, an extra car may have to be put on or taken off, the time taken for the necessary shunting is rather high.

It is also very complicated if not impracticable to run more than two high-powered motor cars by this system, so that the total number of cars is limited to five (four being the normal), any extra trailer cars causing a drop in the schedule speed.

Multiple Unit Control.

In this system, which is applied both to direct and alternating currents, the various contacts in the direct control controller take the form of separate switches or contractors, which are housed conveniently, preferably as near the motors as possible, so as to economise wiring. The contractors are operated from a master controller placed in the motorman's compartment, and this controller operates, either by electro-magnets or air pressure, the main switches. The electro-magnetic system is the one more generally in use, and the energising current is obtained (*a*) from the line with direct-current voltages up to 600 volts, (*b*) from a rotary transformer or converter with direct-current voltages over 600 volts, and with alternating-current systems.

With both the direct and multiple unit systems of control the series parallel method of operating the motors is in vogue where direct current is used. By this method, instead of connecting each motor directly across the line voltage with starting resistances in circuit and gradually cutting the latter out, the motors are connected two in series and with the starting resistance. After this resistance has been cut out the motors are placed directly across the line voltage again with resistance in series, and this is gradually cut out until the motors are subjected to the full voltage. The advantages gained are:—

(1) Two free running speeds—half speed and full speed—without rheostatic loss.

(2) Decrease in energy losses due to the current passing through the resistances during the starting period.

With the series parallel control the rheostatic losses amount to $23\frac{1}{2}$ during the starting period, compared with 50 per cent if a plain parallel control were used. The rheostatic loss on a mile run with a four-car train weighing 150 tons and equipped with eight 150 H.P. motors is 14 per cent with series parallel control, and would amount to 31 per cent with parallel control only. This is an item of much importance on a suburban line with frequent stations at short intervals.

Of late years automatic working of the M.U. control has been adopted in some instances. In this system the motorman places his controller handle in the full series or full parallel position as required, the intermediate contractors being operated automatically, their operation being governed by the current through the motors—that is, the first contactor allows the full starting current to pass through the motors, this amount being governed by the amount of starting resistance. As the motors begin to revolve this current falls away, and when it has reached a pre-determined amount a relay operates the second contactor, which brings up the current to its maximum value. It again falls away, and the

Weights of Lengths of Rolled Steel Sections.

Beam 6 in. × $4\frac{1}{2}$ in. × $19\frac{1}{2}$ lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	Ft.
0	..	1 2 27·0	3 1 26·0	5 0 25·0	6 3 24·0	8 2 23·0	10 1 22·0	12 0 21·0	13 3 20·0	15 2 19·0	0
1	0 0 19·5	1 3 18·5	3 2 17·5	5 1 16·5	7 0 15·5	8 3 14·5	10 2 13·5	12 1 12·5	14 0 11·5	15 3 10·5	1
2	0 1 11·0	2 0 10·0	3 3 9·0	5 2 8·0	7 1 7·0	9 0 6·0	10 3 5·0	12 2 4·0	14 1 3·0	16 0 2·0	2
3	0 2 2·5	2 1 1·5	4 0 0·5	5 2 27·5	7 1 26·5	9 0 25·5	10 3 24·5	12 2 23·5	14 1 22·5	16 0 21·5	3
4	0 2 22·0	2 1 21·0	4 0 20·0	5 3 19·0	7 2 18·0	9 1 17·0	11 0 16·0	12 3 15·0	14 2 14·0	16 1 13·0	4
5	0 3 13·5	2 2 12·5	4 1 11·5	6 0 10·5	7 3 9·5	9 2 8·5	11 1 7·5	13 0 6·5	14 3 5·5	16 2 4·5	5
6	1 0 5·0	2 3 4·0	4 2 3·0	6 1 2·0	8 0 1·0	9 3 0·0	11 1 27·0	13 0 26·0	14 3 25·0	16 2 24·0	6
7	1 0 24·5	2 3 23·5	4 2 22·5	6 1 21·5	8 0 20·5	9 3 19·5	11 2 18·5	13 1 17·5	15 0 16·5	16 3 15·5	7
8	1 1 16·0	3 0 15·0	4 3 14·0	6 2 13·0	8 1 12·0	10 0 11·0	11 3 10·0	13 2 9·0	15 1 8·0	17 0 7·0	8
9	1 2 7·5	3 1 6·5	5 0 5·5	6 3 4·5	8 2 3·5	10 1 2·5	12 0 1·5	13 3 0·5	15 1 27·5	17 0 26·5	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	0 1·625	0 3·25	0 4·875	0 6·5	0 8·125	0 9·75	0 11·375	0 13	0 14·625	0 16·25	0 17·875	0 19·5	

Weights of Lengths of Rolled Steel Sections.

Beam 6 in. × $4\frac{1}{2}$ in. × $19\frac{1}{2}$ lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	0 17 1 18	1 14 3 8	2 12 0 26	3 9 2 16	4 7 0 6	5 4 1 24	6 1 3 14	6 19 1 4	7 16 2 22	0
10	1 2 27	0 19 0 17	1 16 2 7	2 13 3 25	3 11 1 15	4 8 3 5	5 6 0 23	6 3 2 13	7 1 0 3	7 18 1 21	10
20	3 1 26	1 0 3 16	1 18 1 6	2 15 2 24	3 13 0 14	4 10 2 4	5 7 3 22	6 5 1 12	7 2 3 2	8 0 0 20	20
30	5 0 25	1 2 2 15	2 0 0 5	2 17 1 23	3 14 3 13	4 12 1 3	5 9 2 21	6 7 0 11	7 4 2 1	8 1 3 19	30
40	6 3 24	1 4 1 14	2 1 3 4	2 19 0 22	3 16 2 12	4 14 0 2	5 11 1 20	6 8 3 10	7 6 1 20	3 3 2 18	40
50	8 2 23	1 6 0 13	2 3 2 3	3 0 3 21	3 18 1 11	4 15 3 1	5 13 0 19	6 10 2 9	7 7 3 27	8 5 1 17	50
60	10 1 22	1 7 3 12	2 5 1 2	3 2 2 20	4 0 0 10	4 17 2 0	5 14 3 18	6 12 1 8	7 9 2 26	8 7 0 16	60
70	12 0 21	1 9 2 11	2 7 0 1	3 4 1 19	4 1 3 9	4 19 0 27	5 16 2 17	6 14 0 7	7 11 1 25	8 8 3 15	70
80	13 3 20	1 11 1 10	2 8 3 0	3 6 0 18	4 3 2 8	5 0 3 26	5 18 1 16	6 15 3 6	7 13 0 24	8 10 2 14	80
90	15 2 19	1 13 0 9	2 10 1 27	3 7 3 17	4 5 1 7	5 2 2 25	6 0 0 15	6 17 2 5	7 14 3 23	8 12 1 13	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	8 14 0 12	17 8 0 24	26 2 1 8	34 16 1 20	43 10 2 4	52 4 2 16	60 18 3 0	69 12 3 12	78 6 3 24	87 1 0 8	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues

Weights of Lengths of Rolled Steel Sections.

Beam 9in. × 4 in. × 20½ lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	Ft.
0	..	1 3 9·0	3 2 18·0	5 1 27·0	7 1 8·0	9 0 17·0	10 3 26·0	12 3 7·0	14 2 16·0	16 1 25·0	0
1	0 0 20·5	2 0 1·5	3 3 10·5	5 2 19·5	7 2 0·5	9 1 9·5	11 0 18·5	12 3 27·5	14 3 8·5	16 2 17·5	1
2	0 1 13·0	2 0 22·0	4 0 3·0	5 3 12·0	7 2 21·0	9 2 2·0	11 1 11·0	13 0 20·0	15 0 1·0	16 3 10·0	2
3	0 2 5·5	2 1 14·5	4 0 23·5	6 0 4·5	7 3 13·5	9 2 22·5	11 2 3·5	13 1 12·5	15 0 21·5	17 0 2·5	3
4	0 2 26·0	2 2 7·0	4 1 16·0	6 0 25·0	8 0 6·0	9 3 15·0	11 2 24·0	13 2 5·0	15 1 14·0	17 0 23·0	4
5	0 3 18·5	2 2 27·5	4 2 8·5	6 1 17·5	8 0 26·5	10 0 7·5	11 3 16·5	13 2 25·5	15 2 6·5	17 1 15·5	5
6	1 0 11·0	2 3 20·0	4 3 1·0	6 2 10·0	8 1 19·0	10 1 0·0	12 0 9·0	13 3 18·0	15 2 27·0	17 2 8·0	6
7	1 1 3·5	3 0 12·5	4 3 21·5	6 3 21·5	8 2 11·5	10 1 20·5	12 1 1·5	14 0 10·5	15 3 19·5	17 3 0·5	7
8	1 1 24·0	3 1 5·0	5 0 14·0	6 3 23·0	8 3 4·0	10 2 13·0	12 1 22·0	14 1 3·0	16 0 12·0	17 3 21·0	8
9	1 2 16·5	3 1 25·5	5 1 6·5	7 0 15·5	8 3 24·5	10 3 5·5	12 2 14·5	14 1 23·5	16 1 4·5	18 0 13·5	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs. 1·70	lbs. 3·41	lbs. 5·12	lbs. 6·83	lbs. 8·54	lbs. 10·25	lbs. 11·95	lbs. 13·66	lbs. 15·37	lbs. 17·08	lbs. 18·79	lbs. 20·5	Weight.

Weights of Lengths of Rolled Steel Sections.

Beam 9 in. × 4 in. × 20½lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	0 18 1 16	1 16 2 12	2 14 3 18	3 13 0 24	4 11 2 2	5 9 3 8	6 8 0 14	7 6 1 20	8 4 2 26	0
10	1 3 9	1 0 0 15	1 18 1 21	2 16 2 27	3 15 0 5	4 13 1 11	5 11 2 17	6 9 3 23	7 8 1 1	8 6 2 7	10
20	3 2 18	1 1 3 24	2 0 1 2	2 18 2 8	3 16 3 14	4 15 0 20	5 13 1 26	6 11 3 4	7 10 0 10	8 8 1 16	20
30	5 1 27	1 3 3 5	2 2 0 11	3 0 1 17	3 18 2 23	4 17 0 1	5 15 1 7	6 13 2 13	7 11 3 19	8 10 0 25	30
40	7 1 8	1 5 2 14	2 3 3 20	3 2 0 26	4 0 2 4	4 18 3 10	5 17 0 16	6 15 1 22	7 13 3 0	8 12 0 6	40
50	9 0 17	1 7 1 23	2 5 3 1	3 4 0 7	4 2 1 13	5 0 2 19	5 18 3 25	6 17 1 3	7 15 2 9	8 13 3 15	50
60	10 3 26	1 9 1 4	2 7 2 10	3 5 3 16	4 4 0 22	5 2 2 0	6 0 3 6	6 19 0 12	7 17 1 18	8 15 2 24	60
70	12 3 7	1 11 0 13	2 9 1 19	3 7 2 25	4 6 0 3	5 4 1 9	6 2 2 15	7 0 3 21	7 19 0 27	8 17 2 5	70
80	14 2 16	1 12 3 22	2 11 1 0	3 9 2 6	4 7 3 12	5 6 0 18	6 4 1 24	7 2 3 2	8 1 0 8	8 19 1 14	80
90	16 1 25	1 14 3 3	2 12 4 9	3 11 1 15	4 9 2 21	5 7 3 27	6 6 1 5	7 4 2 11	8 2 3 17	9 1 0 23	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	9 3 0 4	18 6 0 8	27 9 0 12	36 12 0 16	45 15 0 20	54 18 0 24	64 1 1 0	73 4 1 4	82 7 1 8	91 10 1 12	

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Differeni Rolled Steel Sections will appear in future issues.

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ENGINEERS, DRAUGHTSMEN, &c.

ELECTRICAL ENGINEER wanted for Contracting Firm in Burmah; must be well educated, thoroughly experienced, with sound knowledge of both A.C. and D.C. winding work, and able to take charge; unmarried; five years' agreement; salary Rs. 350 per month, rising Rs. 50 per month each year; passage paid; good prospects.—Apply, stating age, experience and references, to Hendry Brothers Ltd., 71, Queen Street, Glasgow.

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THE METROPOLITAN WATER BOARD require the services of three CIVIL ENGINEERING DRAUGHTSMEN, accustomed to the Preparation of Drawings customary in a Waterworks undertaking; also two MECHANICAL ENGINEERING DRAUGHTSMEN, experienced in the design of Steam Power Plants and Pumping Machinery.

The appointments are of a temporary character, and will be held during the pleasure of the Board, at an inclusive salary of £225 per annum.

Applications, with particulars of training and experience, are to be sent to the Clerk of the Metropolitan Water Board, 2, South Place, Finsbury, E.C. 2, endorsed "Civil Engineering Draughtsmen" or "Mechanical Draughtsmen."

WANTED, JUNIOR DRAUGHTSMAN; some experience in internal-combustion engines desired.—Apply R. A. Lister and Co. Ltd., Engine Department, Dursley.

ENGINEERS, DRAUGHTSMEN, &c.

WANTED, a Young CIVIL ENGINEER of good address (Public School man preferred) who has experience in roadmaking as well as some knowledge of mechanics and internal-combustion engines, to represent and travel on behalf of Messrs. Barford and Perkins Ltd., Motor Roller Works, Peterborough.

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DRAUGHTSMAN, having all-round practical experience in Fan Work, capable correspondent.—Apply in confidence, Managing Director, Standard Engineering Co. Ltd., Leicester.

ENGINEER, reliable, wanted immediately, to take charge of engines and steam-raising plant; applicants must state age, experience and wage required.—Apply W. S. Mallalieu, Jackson and Steeple Ltd., Riverside Mills, Stalybridge.

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WANTED, immediately, highly-skilled TURNERS for heavy, medium, and light work; highly-skilled MARKER-OUT for good-class work; highly-skilled JIG and GAUGE MAKER.—Apply giving full particulars, experience, age, etc., the Brush Electrical Engineering Co., Loughborough.

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TRADE ITEMS, NOTES, &c.

As an indication of the German activities for regaining their trade in the future, it may be mentioned that one large German electrical company has purchased 15 acres of land just outside of the city of Malmö, in the southern part of Sweden, with the intention of erecting a factory on this site. According to the *Swedish-American Trade Journal*, at least six other German firms have taken similar steps.

A conveyer plant has recently been erected for Messrs. William Baird and Co. Ltd., at their Gartsherrie Ironworks, Coatbridge, by Messrs. Richard White and Sons, of Widnes. The problem was the unloading of railway wagons as they come into the works with iron ore, at the same rate as it is hoped that in future the steamers will load the ore into wagons at the port—possibly 300 tons of ore per hour.

Brigadier-General E. H. Hills, C.M.G., D.S.C., F.R.S., and Major-General A. J. de Lotbiniere, C.B., C.S.I., C.I.E., have entered into partnership as consulting engineers with the style of Hills and De Lotbiniere, specialising in the departments of hydro-electric generation and transmission, water supply, and drainage. Pending the completion of office arrangements, Brigadier-General Hills is dealing with inquiries at 1, Campden Hill, London, W.8.

THE STRENGTH OF FERRO-CONCRETE VESSELS.—Owing to rumours of less satisfactory experiences with ferro-concrete vessels abroad, a Danish ferro-concrete shipbuilding company has asked the Director of the Norwegian Veritas for his opinion. It may be mentioned in this connection, that the Norwegian Veritas was the first Institution of its kind to issue rules for the classification of sea-going ferro-concrete vessels, and to classify such vessels. A fair number of ferro-concrete vessels and lighters have been built in Norway to Norwegian Veritas class, so that the Institution has some experience with this method of construction. The director has now given expression to an opinion, which reads as follows: "In the experience the Norwegian Veritas has had so far with regard to sea-going vessels of ferro-concrete, such vessels have proved themselves technically satisfactory, inasmuch as they have proved watertight and of sufficient strength. There have been no cracks which have caused leakage, and no trouble has been experienced in making the repairs necessary after collision or grounding.

BRITISH WATERWORKS ASSOCIATION.—It has been decided to hold a summer general meeting of this Association at Leeds, on Thursday and Friday, June 26th and 27th, 1919. The memorandum by Mr. C. G. Henzell, M.Inst.C.E., on "The National Control of Water Sources" (adjourned from the annual general meeting at Birmingham on October 6th, 1918) will be read and discussed. The meeting will consider "The Joint Industrial Council for the Waterworks Undertaking Industry." An inspection of works will also be arranged. Members proposing to attend should write as soon as possible to Mr. Henzell, M.Inst.C.E., Waterworks Offices, Great George Street, Leeds, in order to book hotel rooms for one or two nights as the case may be.

INDUSTRIAL ESSAY COMPETITION.—*Unity*, the organ of the National Alliance of Employers and Employed, offers prizes amounting to £200—presented by Sir Robert Hadfield, Bart.—for the best essay on either of the following subjects: A practical scheme for the joint development of industry by Capital and Labour; the most effective means for the prevention of unemployment; the most effective means for the prevention of industrial disputes. There are to be one first prize of £100, one second prize of £50, one third prize of £10, and eight prizes of £1 each. The Committee of Award will consist of: The Right Hon. Frederick Huth Jackson, P.C. (Chairman of the National Alliance of Employers and Employed); the Master of Balliol College, Oxford; the Right Hon. Arthur Henderson, P.C. The competition closes on August 30th, 1919. Further information can be obtained from *Unity*, 64, Victoria Street, London, S.W.1.

third contactor is brought in, and this continues until the motors have attained their full series or full parallel positions respectively.

The advantage claimed for it is that it prevents the motorman damaging the motors by cutting out his resistances too rapidly, and that it gives a smooth acceleration to the train, since its operation is dependant on the value of the motor current, and in consequence the maintenance of the motors and gearing is reduced.

It should be borne in mind, however, that the automatic control is not a unit saver; as a matter of fact, in certain instances, it is the reverse. Its adoption entails the employment of relays and a large number of secondary interlocking contacts, which introduce complications and require a considerable amount of maintenance. It is very problematical, whether with motors of modern design and efficiently trained motormen, there is any advantage to be gained from automatic control.

Alternating-current Systems.

Alternating-current systems are of two kinds—single-phase and three-phase. The principle advantage claimed for alternating-current systems is that the power can be delivered to the cars or locomotives at high tension without the use of intermediary converters and low-tension conductors from the converting stations to the cars which are necessary with direct-current traction. Thus, the first costs and running losses of the transmission plant are very much lower than with direct current; the maintenance costs of sub-stations, where required, is practically nil, as there is no running machinery, and constant supervision is not needed. With single-phase motors a large number of running speeds without rheostatic losses can be obtained, and with three-phase motors the question of regenerative control is free from the heavy complications of the direct-current or singe-phase systems.

On the other hand the weights and costs of the train equipments, both control and motors, are the lowest with direct current. The characteristics of the direct-current series motor are much better adapted to traffic requirements, especially for suburban traffic, and their general reliability is greater. Overhead structure is necessary for alternating-current working, and three-phase systems have the added disadvantage of requiring two overhead conductors. The increased voltages which have been found possible during recent years with direct current have, however, brought it more into line with alternating-current traction as regards cost of intermediary converters and low-tension conductors, thus discounting the one advantage alternating current had over direct current. Direct-current voltages of 3,600 have been used successfully in this country, and as high as 5,000 is in use in the States. These high voltages, of course, necessitate the use of overhead conductors, as it is not advisable to have higher voltages than 1,500 on the live rail.

It may be said therefore that unless some very big advance is made in alternating-current traction that direct-current traction will fulfil the various conditions of traffic required—suburban, express passenger, and goods—better than any other system.

There is very little alternating-current traction in this country; the only two railways which have tried it are the L.B. and S.C. on their line out of London, where a length of 26 miles has been electrified, and extensions are being carried out on another 70 miles, and the Midland Railway, who have electrified $9\frac{3}{4}$ miles of route between Heysham and Lancaster.

These are both single-phase lines, there being no examples of three-phase traction in this country. More use of alternating-current traction, however, is made on the Continent and in the States, the relative lengths for the principal electrifications being as follows at the beginning of 1917:—

	Miles of single track. British.	America.
Direct current	489	1,052
Single phase	83	753
Three phase	None.	6

The more recent electrifications in America, howevr, have been high voltage direct current, the distributing voltages in two instances being 2,400 and 3,000 respectively.

Recent Progress and Future Developments.

Progress during the last four years has, of course, been very seriously handicapped in this and the allied countries, but still attention may be drawn to some important advances which have taken place during this period. Of these two, the Newport-Sheldon line of the North-Eastern Railway and the Manchester-Bury line of the Lancashire and Yorkshire Railway stand out as the first examples of their kind in this country in which use is made of direct current at high voltage.

These two examples are all the more interesting, as they represent two entirely distinct applications of heavy electric traction, the one being used for heavy goods traffic, and the other for heavy suburban passenger traffic.

The Newport-Sheldon Line.

The Newport-Sheldon line, which is a purely mineral line, is 18 miles long with an equivalent of 50 miles of single track. The power is distributed to the locomotives by overhead conductors at 1,500 volts, and the motors operate at 750 volts, two being in series across the mains in the parallel position. This line was opened for a limited service in July, 1915.

It is interesting to note that this line forms part of the original Stockton and Darlington Railway, which was opened in 1825, and on which the first passenger service in the world run by steam locomotives was inaugurated.

The locomotives, which were designed and built at the North-Eastern Railway Locomotive Works, are of the double-bogie type, connected by a buffer coupling. Each locomotive is equipped with four motors of 275 B.H.P. each at a one-hour rating with forced ventilation, and the locomotive, the total weight of which is about 75 tons, is capable of hauling a load of 1,400 tons at a speed of not less than 25 miles per hour, the average tractive effort during the starting period being 28,000 lbs.

The Manchester-Bury Line.

The Manchester-Bury line is $9\frac{1}{2}$ miles long with an equivalent of 22 miles of single track. The power is

distributed to the trains by a side contact live rail at 1,200 volts. This is the first time use has been made of a side contact rail in this country, and this type lends itself to efficient guarding from accidental contact by the staff. Its adoption during the three years it has been in use has proved very successful. The motors operate at line voltage, and multiple unit control, which can be worked either manually or automatically, is in operation.

The line was opened for traffic in April, 1916, and at present a 20 minutes' service, with 10 minutes at the rush hours, is being maintained, with, in general, five-car trains. The whole of the electrification was undertaken by the L. and Y. Railway and the motor coaches were designed and built by them at their locomotive and carriage shops. The five-car train weighs 226 tons, and consists of three motor cars and two trailers, the seating capacity being 389.. The maximum speed on the level is 52 miles per hour, and the maximum acceleration is 3 ft. per second. The equivalent tractive effort during the starting period is 45,000 lbs. Each motor is equipped with fou 200 B.H.P. motors at one-hour rating with natural ventilation.

In addition to these electrification schemes have been put into operation by the L. and S.W. Railway and the L. and N.W. Railway.

The L. and S.W. Railway Electrifications.

The L. and S.W. Railway have electrified 47 route miles of line from Waterloo to Wimbledon, Kingston, and Hampton Court. The service has been running for three years with eminently satisfactory results. This is a direct-current 600-volt over-running live-rail system with multiple unit control automatically operated.

The L. and N.W. and Bakerloo Lines.

The L. and N.W., in conjunction with the Bakerloo Railway, have electrified a considerable length of line in the north-west of London, the latest extension being to Watford, the distance from Euston to Watford being 17 miles. This system is also run at 600 volts, and is similar to the L. and S.W. just quoted.

The L.B. and S.C. and L.S.E. and C. Schemes.

In addition to these, the L.B. and S.C. Railway have an equivalent of 150 miles of single track in process of electrification, and the L.S.E. and C. are embarking on a scheme to electrify their suburban lines out to Dartford.

Positions of the Various Railway Companies.

The positions of the various railway companies at the beginning of 1914 and the beginning of 1917 are given in the following table:—

	Length of single track electrified. Miles. 1914.	1917.
London, Brighton, and South Coast	$60\frac{1}{2}$	62
London and North-Western	—	$84\frac{3}{4}$
London and South-Western	$3\frac{1}{4}$	150
Lancashire and Yorkshire	$89\frac{1}{2}$	$111\frac{1}{2}$
Midland	21	21
North-Eastern	$65\frac{1}{2}$	130
Total	$239\frac{3}{4}$	$559\frac{1}{4}$

This gives an increase of 133 per cent, which, it must be remembered, has taken place during war period, and with the extensions contemplated there is no doubt that this rate of increase will in itself be greatly increased when times become more normal.

In the United States.

In the States the most noteworthy instance of progress is the electrification of a 440-mile section of the Chicago, Milwaukee, and St. Paul Railway. This section includes the mountainous division over the Rockies where the gradients are exceptionally heavy, there being one of 1 in 50, 21 miles long, and one of 1 in 100, 49 miles long. The traffic, both passenger and goods, is worked wholly by electric locomotives at 3,000 volts direct current, the power being supplied through overhead conductors. The motors of which there are 12 per locomotive are operated at a maximum voltage of 1,000 or three in series. The total horse power per locomotive is 3,240 at the hour rating, at which the tractive effort is 46,000 lbs. The starting tractive effort is 91,600 lbs., and they are capable of hauling a 1,000-ton train up a 1 in 50 gradient at 25 miles per hour. This electrification is an excellent example of the application of high voltage direct current on a large scale, and its success during the three years since its installation is a good augury for this method of traction.

Future Developments.

With regard to future developments, the question of standardisation has already been mentioned, and though this ought most decidedly to be borne in mind when future electrifications are contemplated, and ought to have some effect on the general policy adopted, yet it does not seem that the time is ripe for wholesale standardisation of systems. The effect of standardisation generally is to handicap progress, and some degree of finality in main principles at least might be reached before standardisation can take place. Some attempt at the standardisation of the live rail has already been made so long ago as March, 1903, when the railway engineers fixed the position of the live rail for an over-running shoe. The advent of the side contact live rail for 1,200 volts, however, has already raised another standard, though there would be no difficulty in arranging it so that it could be used for either top or side contact at will.

Take the question of voltage, which should be the first item to be standardised. There are already three direct-current line voltages—600, 1,200, and 1,500—and an experimental line at 3,600 volts has given very satisfactory results. It would therefore appear that fuure voltages should be some multiple of 600, say, 1,200, 2,400, and 3,600, leaving higher multiples for future developments. Motors are now made and have been successfully employed with 1,800 volts across one commutator, and two of these connected permanently in series give the line voltage of 3,600 mentioned above. The development of the double-armature motor, which includes two armatures in one frame and is already in use on the Chicago, Milwaukee, and St. Paul Railway, will, by dividing up the voltage between two commutators, enable still higher line voltages to be used. The selection of standard voltages which are multiples of existing voltages also gives the opportunity, by altering the

motor arrangement, of changing over from a lower to a higher voltage without the cost of having to provide a new motor equipment. Enough has been said to show that though it is very advisable to adopt temporary standards and to take thought for the future it would be unwise, unless we are content with the present state of affairs, to propose or make any permanent ones.

In conclusion, the author, whilst admitting that there is very little that is new in this paper and that very much more could be said, hopes that it may have some points of general interest and that it may lead to some interchange of thought and opinion.

(Concluded.)

THE UNAFLOW STEAM ENGINE.

By D. H. YATES.

(Continued from page 310.)

Flywheel.

The value of X affects the weight of the flywheel in inverse proportion, *i.e.*, if X is doubled, the weight W lbs. of the flywheel is halved. W again is dependent on the "coefficient of energy fluctuation" k.

$$k = \frac{\text{Maximum excess energy}}{\text{Energy exerted in one revolution.}}$$

k for a Unaflow engine may vary from .11 to .13.

$$\text{Now if } K = \frac{\text{Stored energy in flywheel}}{\text{Work done by engine per revolution}},$$

then k = K2X.

These three values, k, K, and X are interdependent, and should always be considered in determining the weight of the flywheel.

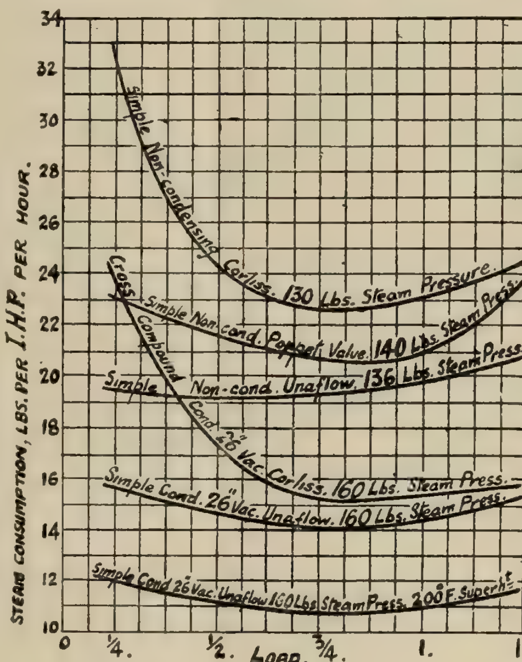
For the purposes of this paper it will suffice to state that the weight of flywheel required for a Unaflow engine is slightly less than for a tandem-compound engine running at the same speed. As, however, the Unaflow engine runs at a greater speed than a tandem, there is a still further reduction in flywheel weight. If the engine is required to work steadily non-condensing or with much overload, an increase in weight of the flywheel above that for a purely condensing engine at normal load is necessary.

Efficiencies.

The mechanical efficiency of the Unaflow engine—*i.e.*, $\frac{\text{B.H.P.}}{\text{I.H.P.}}$ is very high, and averages about 93 per cent, but in some cases 95 per cent has actually been reached, including the air pump drive. This high mechanical efficiency is due chiefly to the small number of moving parts.

THERMO-DYNAMIC EFFICIENCY.—Assume steam at 155 lbs. gauge pressure superheated to 480 deg. Fah. Let B.T.U. in live superheated steam − B.T.U. in exhaust steam = 100 per cent. Then the Unaflow engine has a thermo-dynamic efficiency of about 66 per cent. If we take the total B.T.U. in live steam = 100 per cent, then the thermal efficiency is only about 19 per cent, the other 81 per cent being passed into the condensing plant or lost by condensation, radiation, conduction, etc., the bulk of which passes off in the water from the hotwell. Further increase of pressure and superheat will increase these efficiencies slightly.

Whilst dealing with efficiencies it would perhaps be as well to make a few remarks relative to the manner in which a portion of this great loss of heat from the engine can be eliminated by using it whilst in the steam for process work in mills. A good many mill processes require heat or steam, and the need for economy in manufacture has resulted in the use of the steam-extraction engine, which is usually built in the form of a tandem-compound engine in which process steam is extracted from the receiver between the high-pressure and low-pressure cylinder at the required pressure, perhaps 20 lbs. per square inch, and conveyed to the mill, where the heat still contained in the steam is used efficiently instead of a great portion running to waste after passing through the low-pressure cylinder. The high-pressure cylinder is often of the counterflow type owing to the need for two exhaust valves, due to the variable back pressure in the high-pressure cylinder,



UNAFLOW STEAM ENGINE.—FIG. 20.

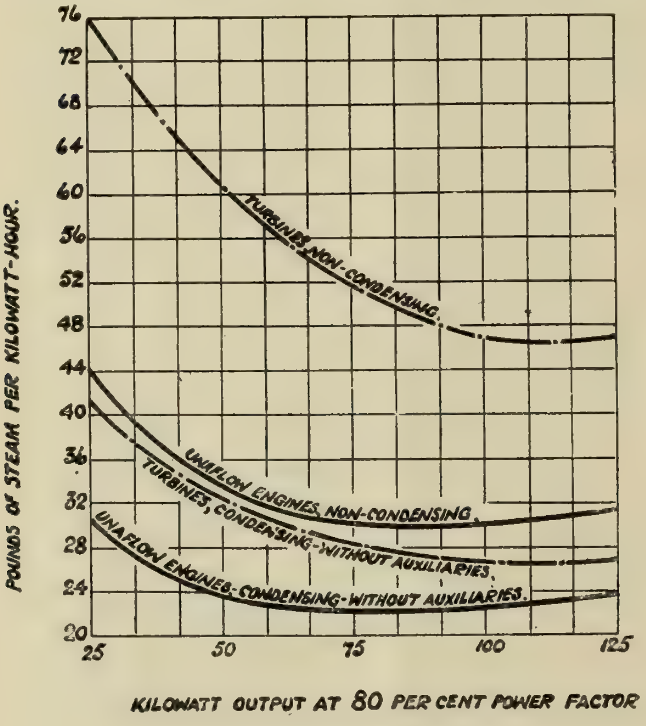
but a Unaflow cylinder is eminently suitable for the low pressure and gives excellent results. Both cylinders would in this case have the valve gear driven by means of a lay shaft alongside the cylinders. The high-pressure cylinder could also be made on the Unaflow principle if desired by placing an auxiliary exhaust valve in the piston operated from the engine crosshead, the compression thus being regulated to take place over a short period. The objection to this arrangement is that the accessibility to the auxiliary valve is very poor indeed.

Another method of steam extraction is by means of non-return valves placed in the cylinder barrel at the required portion of the stroke, but this method cannot be recommended in most cases, as the quantity of steam extracted is not under control to the same extent.

Steam Consumption.

It is in this section that we come to the deciding factor which regulates to a great extent the decision as to whether the Unaflow engine is more economical than the compound or triple-expansion engine or the steam turbine. For this purpose the best that can be done is to provide independent testimony as to the superiority of the Unaflow engine.

In the *Mechanical World* for November 9th, 1917, was an article headed "The Poppet-valve Steam Engine," by S. Rosenzweig, who, in a paper presented at a meeting of the New York section of the A.S.M.E., gave comparative steam consumptions of Corliss, poppet-valve, and Unaflow poppet-valve engines. Fig. 20 shows the results given, and clearly demonstrates the advantage of the Unaflow engine using superheated steam over one using



Unaflow Steam Engine.—Fig. 20a.

saturated steam, the advantage of the Unaflow over the poppet-valve counterflow engine, and again the advantage of the latter over the Corliss engine when working either condensing or non-condensing under similar conditions for each type. The Unaflow engine can also equal, and sometimes surpass, the steam consumption of triple-expansion engines.

A comparison of steam consumptions for Unaflow engines and steam turbines is afforded by Mr. L. A. Quayle, Mechanical Engineer of the Cleveland Water Department, U.S.A., who, in an article in *Power*, June 6th, 1916, headed "Performances of Unaflow Engine and Turbine Compared," gave the steam consumption guarantees of engine and turbine builders plotted in the form of a curve, as shown by Fig. 20a, which clearly demonstrates the superiority of the Unaflow engine. The results given are regarded as conservative, as there was a penalty of 700 dollars per pound of steam per kilowatt hour for failure to meet the guarantee, and no bonus was offered for exceeding the guaranteed economy.

Further proof need not be given that the Unaflow engine fully justifies the claims made for it with regard to economy in steam consumption, and the author's firm has carried out tests on this type of engine of various sizes which they have constructed with satisfactory results. Moreover, as the engine is more carefully studied in the light of previous experience, there is no reason to doubt that the steam consumption will be still further reduced. Perhaps it will be interesting to give the actual test figures of a medium-sized Unaflow engine made by the Bolton firm which was the first to realise the merits of this particular type of engine. Results of a test made on a horizontal Unaflow engine at Messrs. J. Binney and Co., Buckingham Mill, Madras, India, by the mill engineer, Mr. F. Thomas.

The engine was built for 500 I.H.P. at 130 revolutions per minute with 160 lbs. boiler pressure, and is fitted with Edwards' air pumps and contraflow surface condenser: Cylinder, 27 in. diameter with 3-ft. stroke; speed, 129 revolutions per minute; boiler pressure, 160 lbs. gauge; engine stop valve pressure, 152 lbs. gauge; superheat at stop valve, 50 deg. Fah.; cylinder vacuum, 26 in.; indicated horse power, 317; coal per indicated horse power per hour, 1.41 lbs.; pounds of water evaporated per pound of coal, actual, 7.73; steam consumption per indicated horse power per hour, 10.98 lbs. This steam consumption agrees fairly well with that given in Fig. 20.

An average of the tests of engines of the Unaflow, triple-expansion, and compound types works out as follows:—

No. of Engines.	Type.	I.H.P.	Boiler Gauge Pressure.	Super-heat.	Steam Consumption per I.H.P. per hour.
				deg. F.	
10	Unaflow ...	464	160 lbs.	39·6	11·13 lbs.
5	Triple Exp.	1015	175·3 lbs.	42·6	11·3 lbs.
10	Comp......	513	145·7 lbs.	62·4	13·3 lbs.

(*To be continued.*)

SOME THERMAL RELATIONS OF COAL, ELECTRICITY, AND GAS, FROM A NATIONAL STANDPOINT.*

By Ed. C. de Segundo, Assoc.M.Inst.C.E., M.Inst.Mech.E., M.Inst.E.E.

"The horror of the waste of food is inborn, the horror of the waste of coal has still to be acquired," writes Professor Soddy in his excellent manual, "Matter and Energy," and he goes on to say "the cost at the pit's head no more has any relation to the real value of the coal than the cost of its transport above ground. . . . It is not possible to reckon what the cost of coal has been in the economy of Nature nor how many ages of future time will be necessary to recuperate the amount now burned in a single year. On this irreplaceable and diminishing commodity the future prospects of civilisa-

* *The Gas World*

tion depend." A solemn warning this; but how many have read Professor Soddy's "Matter and Energy," and how many of his readers realise their individual responsibility in the direction of economy in the use of this irreplaceable and diminishing commodity upon which the future prospects of civilisation depend?

From the point of view of national economics, an examination into the relative merits of gas, coal, and electricity, considered as "working materials" for the generation of heat, may usefully be based upon the net equivalent consumption of coal for the production of a given quantity of "effective" heat—that is to say, of heat which is actually applied to the purpose intended. Any consideration of the physiological, the hygienic, and the ethical aspects of the heating question must be left out of account, not because these are unimportant (they are, indeed, very important), but because adequately to treat of them would go far beyond the space at my disposal. Nor can any attempt be made to estimate the cash value of the renewal of the air in a room, effected by the draught up the chimney induced by the burning of coal in an open grate, or by the escaping products of combustion of a properly installed gas fire. But as this heat loss is incurred in effecting a useful purpose, the coal fire and the gas fire should, in any comparison with the electric heater, be credited in some manner with the heat value of such ventilating effect.

The coal consumed in the open grate and under the boilers of the electric generating steam plant is, of course, entirely destroyed and the volatile constituents and other valuable by-products are practically wasted, whereas in the carbonisation of coal the volatiles are preserved, and secondary products, both combustible and non-combustible, are obtained, which are of great value, and some of which may be destined to become of national importance in the not very distant future.

Progress in Gasworks Practice.

As representative of average practice in gasworks throughout the kingdom, we may assume, per ton of coal carbonised, a make of 12,000 c. ft. of about 500 B.Th.U. gas supplied to the customer; a production of 10 cwt. of coke available for sale (*i.e.*, after allowance is made for the coke used in heating the retorts), and of 10 gals. of coal tar. Under normal conditions we may take the calorific value of the coke at 12,500 B.Th.U. per pound, and that of the coal tar at about 16,500 B.Th.U. per pound. Thus the thermal value of the combustible secondary products per ton of coal distilled may be put at about 15,000,000 B.Th.U., or, roughly, about the equivalent of half a ton of the original coal. The thermal value of the gas produced is about 6,000,000 B.Th.U., so that about 21,000,000 B.Th.U. reappear, potentially, in the products of gasification in a reasonably modern gasworks, out of about 30,000,000 B.Th.U. in the original ton of coal, or about 70 per cent of the original heat value of the coal carbonised.

Progress is continually being made in carbonising methods, and some results have recently been published showing that by the downward steaming method a make of over 17,000 c. ft. of gas, of a trifle over 500 B.Th.U. per c. ft., has been achieved on a practical working scale. The most remarkable concomitant feature of the various "steaming systems" is the largely increased production of sulphate of ammonium, a product of rapidly growing economic value. In the case above referred to (the figures were published in the *Times* Trade Supplement for March) it is stated that nearly 40 gals. of ammoniacal liquor were obtained, equivalent to 33 lb. of sulphate of ammonium per ton, or an increase over the quantity obtained in the ordinary system of horizontal carbonisation of about 27 per cent. The "thermal efficiency" of the carbonising process in such circumstances would be well over 80 per cent.

Steam and Gas Engines.

It may be of interest to glance at the relative merits of the direct combustion of coal in the best modern steam engine practice, and of the possibilities attaching to the employment of coal gas in modern gas engines, and also of the value of the combustible secondary products for steam raising. Our coal is taken to contain potentially 13,000 B.Th.U. per pound. About $11\frac{1}{2}$ lb. of air would be required, theoretically, for the complete combustion of one pound of such coal. This minimum is never realised in practice, and 15 lb. of air per pound of coal burned would be considered a satisfactory result. Needless to say, the quantity of air passing through the boiler furnace is often very much higher than this, but, taking it at 15 lb., the products of combustion discharged up the chimney under normal conditions will unavoidably carry away about 2,600 B.Th.U. per pound of coal burned. Thus the maximum proportion of the total heat of the coal which could theoretically become available for steam raising in a boiler is about 10,400 B.Th.U., and of this about 2,200 B.Th.U. would, in the highest class steam engine practice, appear in the form of available b.h.p.

The potential heat value obtained from the combustible products of carbonising coal, using the gas for power generation in a gas engine, and coke and coal tar for steam raising, would be roughly as follows:—

One pound of coal yields, on our assumptions, $\frac{12,000}{2,240}$ or nearly 5·4 c. ft. of 500 B.Th.U. gas, or 2,700 B.Th.U. The combustible secondary products would yield, in heat value, $\frac{15,000,000}{2,240}$ or nearly 6,700 B.Th.U., making a total of 9,400 B.Th.U. Of the 2,700 B.Th.U. of "gas heat," we may take 28 per cent, or 756 B.Th.U., as about the maximum proportion that would appear as b.h.p. in practice in the very best gas engines. Recent trials have shown that we may take about 15 per cent of the heat value of the combustible secondary products, or about 1,000 B.Th.U., as convertible into available energy by means of a suitably adapted steam boiler and engine. Thus—as a matter of pure arithmetic—the relative potentialities of power production by the direct combustion of coal and by the utilisation of the combustible products of the carbonisation of coal under the best conditions of efficiency would appear to be in the proportion of 2,200 to 1,756, or of 1 to 0·80. But—as a matter of practice—this comparison is unfair to gas, because in many cases a much higher efficiency of transformation of energy is attained in gas engines than in steam engines under practical everyday working conditions, particularly in the smaller sizes.

(*To be continued.*)

It is announced that a new steel corporation has been established in Canada, with a capital of £3,000,000, to manufacture motor cars and parts, trucks, and tractors. The corporation has secured land at Goderich, Ontario. It is proposed to bring ore from Michigan and to manufacture high-carbon steel.

LUBRICATION OF AIR COMPRESSORS.

By H. V. CONRAD, M.E., Secretary, Compressed Air Society, New York.

(*Concluded from page 336.*)

Periodical Cleansing of System.

The best of lubricating oils will cause the deposit of enough carbon in the compressor system to necessitate the periodical cleansing of it.

For the removal of carbon the machine operator should confine his efforts to the use of soap suds. A good cleansing solution is made of one part soft soap to fifteen parts water. These suds should take the place of oil for a few hours, and be fed into the air cylinders about once a week, either by means of a hand pump or through the regular lubricator at a rate about ten times as rapidly as that of the oil. The cleanliness of the air valves when inspected, as they should be periodically, will indicate whether greater or lesser applications of the soap suds should be made.

After using soap suds, open the drain cock of the air receiver, and of the intercooler in the case of compound machines, to draw off any accumulated liquid. Oil should be used again for a half hour before shutting down the machine in order to prevent rusting the cylinder and its fittings. Never use kerosene, gasoline, or lighter oils, in an air cylinder for any purpose whatever, because of their volatile nature under heated conditions.

It often happens that oil, carbon, and other foreign matters are deposited in the air discharge lines and air receiver. A practical method of cleaning these is shown in cut attached, where a receptacle made of 6-inch pipe is shown set on top of the discharge pipe. The cut shows plainly the construction and what the different parts represent. If a mixture of one pound of Red Seal Lye and eighteen pounds of water is passed into the discharge line at the rate of 60 or 70 drops per minute, while the compressor is running, this will eat out all the accumulation on the surface of the pipe and in the receiver, and if the blow-off valve on receiver is open, all of this foreign matter will be discharged therefrom. This cleaning solution can be used every month or two or depending on how much accumulation there may be in the receiver.

Steam Cylinder Lubrication.

The proper quantity of oil to be fed to steam cylinders is much greater than to air cylinders, due to the constant washing away of the oil by the steam. Approximately four times as much oil will be needed in the steam cylinders as in those for air, subject, of course, to variable local conditions.

Depending on its viscosity, a pint of steam cylinder oil will furnish from 5,000 to 8,000 drops, and taking an average of about 6,500 drops, and four times as much oil as air cylinders of same size, and working at same piston speeds as given in Table No. 3, the recommended

TABLE NO. 2.—PHYSICAL TESTS OF PARAFFIN BASE OILS.

	Minimum.	Average.	Maximum.
Gravity, Baume	28 to 32 deg.	25 to 30 deg.	25 to 27 deg.
Flash Point, Open Cup	375 to 400 deg. Fah.	400 to 425 deg. Fah.	425 to 500 deg. Fah.
Fire	425 to 450 deg. Fah.	450 to 475 deg. Fah.	475 to 575 deg. Fah.
Viscosity (Saybolt) at 100 deg. Fah.	120 to 180 sec.	230 to 315 sec.	to 1,500 sec.
Colour	Yellowish	Reddish	Dark Red to Green
Congealing Point (pour test deg. Fah.)	20 to 25 deg. Fah.	30 deg. Fah.	35 to 45 deg. Fah.

TABLE NO. 3.—PHYSICAL TESTS OF ASPHALTIC BASE OILS.

	Minimum.	Average.	Maximum.
Gravity, Baume	20 to 22 deg. Fah.	19·8 to 21 deg. Fah.	19·5 to 20·5 deg. Fah.
Flash Point, Open Cup	305 to 325 deg. Fah.	315 to 335 deg. Fah.	330 to 375 deg. Fah.
Fire	360 to 380 deg. Fah.	370 to 400 deg. Fah.	385 to 440 deg. Fah.
Viscosity (Saybolt) at 100 deg. Fah.	175 to 225 sec.	275 to 325 sec.	475 to 750 sec.
Colour	Pale Yellow	Pale Yellow	Pale Yellow
Congealing Point (pour test)	0 deg. Fah.	—0 deg. Fah.	—0 deg. Fah.

TABLE NO. 4.—QUANTITY OF AIR CYLINDER LUBRICANT REQUIRED PER 10-HOUR DAY.

Diameter of Cylinder Inches.	Size of Cylinder Inches.	Displacement per Minute Cubic Feet.	Piston Speed Feet Per Minute.	Sq. Ft. of Cylinder Wall Swept by Piston.	Drops Oil per Minute.	Drops Oils per 10 Hrs.	Sq. Ft. Oiled per Drop.	Number Pints Oil Required per 10 Hrs.*
8	8 × 8	120	344	718	1	600	718	·0375
12	12 × 12	320	408	1230	2	1200	613	·0750
18	18 × 18	880	496	2340	4	2400	585	·1500
24	24 × 24	1730	550	3450	6	3600	575	·2250
30	30 × 30	2940	600	4700	8	4800	590	·3000
36	36 × 36	4550	644	6070	10	6000	607	·3750
42	42 × 42	6700	696	7600	12	7200	633	·4500

*Figures of last column are based upon an estimated 16,000 drops per pint of oil at 75 deg. Fah.

amounts to feed the steam cylinders or their equivalents are given in the following :—

TABLE No. 5.—QUANTITY OF OIL FOR STEAM CYLINDER LUBRICATION. R3

No. Drops Per Minute.	Size of Cylinder Inches.	No. Pints Oil required Per 10 Hours.
4	8 × 8	·4
8	12 × 12	·75
16	18 × 18	1·5
24	24 × 24	2·25
32	30 × 30	3·0
40	36 × 36	3·75
48	42 × 42	4·5

These figures are approximate only, and will vary with the steam conditions, the kind of oil used, and its method of introduction into the steam, also with the boiler compound carried by the steam into the cylinder.

Changing Tested Oils.

When the operator of an air compressor succeeds in obtaining lubricating oils that are giving satisfactory results, he should be very cautious about making a change to other grades, particularly if cheapening the cost is advocated by purchasing and sales agents. But if a change is decided on, the performance of the new lubricants should be most carefully checked up before damage can occur to the rubbing surfaces of the compressor, and to see that no increased amount of deposit collect on the inside walls of the air receiver.

The most satisfactory way to get the quickest results is to put up the problem of lubrications to the local experts of any reputable lubricating companies, and to be governed by their recommendations, which, however, should be based on the foregoing statement.

(*Concluded.*)

THE MEASUREMENT OF LOW TEMPERATURES WITH THERMOCOUPLES.

By THOMAS SPOONER.

[*Abstract.*]

IN connection with some recent investigations, it was necessary to measure temperatures below 0 deg. Cen. For this purpose thermocouples were the most convenient to use. It was known that copper advance couples were satisfactory for temperatures down to liquid air valves, but it was thought that Hoskin's thermocouple alloys, which go under the trade name of chromel-alumel, might be more satisfactory, as they give nearly a straight line calibration at temperatures above 0 deg. Cen.

In order to investigate the thermal e.m.f. of the chromel-alumel material at low temperatures, a copper advance couple with its cold junction in ice water was first checked at the freezing point of mercury, at the sublimation point of CO_2 snow, and at the temperature of boiling oxygen. These tests gave the following formula for the copper advance couple :

$$e = .03959t + .00004582t^2 - .0000000556t^3.$$

The copper advance couple and the chromel-alumel couple were inserted in holes in an iron cylinder which was then placed in a thermos bottle. Liquid air was poured into the bottle until the iron block reached the temperature of the liquid air. The block was then allowed to warm slowly in the thermos bottle and readings were taken of the e.m.f.'s of the two couples. Fig. 1 gives the calibration of the two couples and Fig. 2 the average microvolts per degree between 0 deg. Cen. and the given temperature from

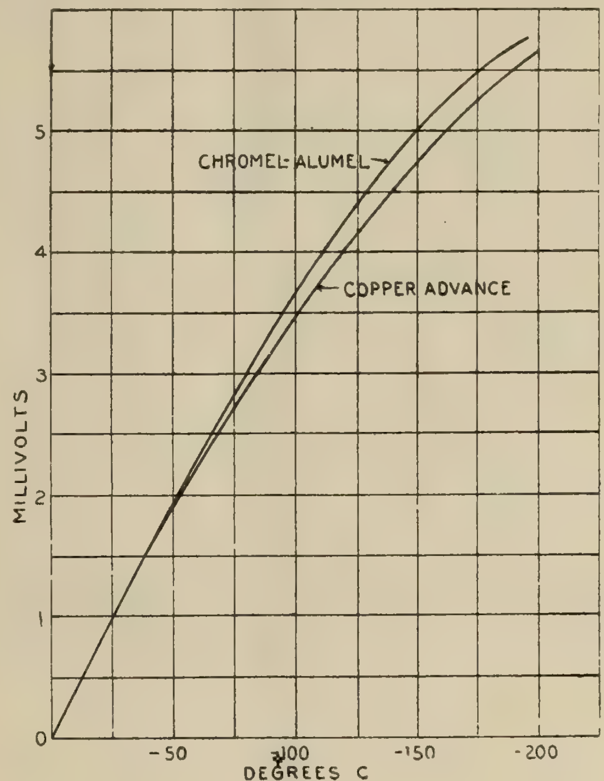


FIG. 1.

+900 deg. Cen. to −190 deg. The high temperature values were obtained by calibration against a standardised platinum-platinum rhodium couple.

It will be noted from Fig. 2 that the microvolts

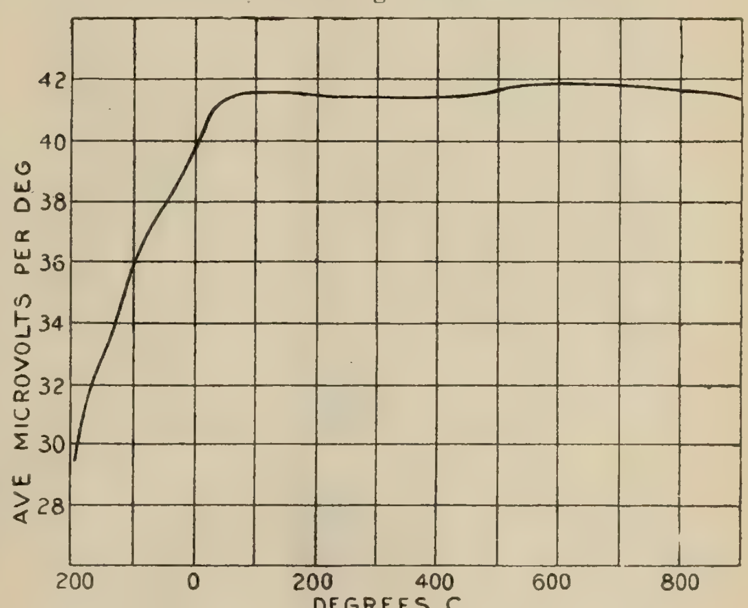


FIG. 2.

drop off very rapidly below 0 deg. Cen., and that the chromel-alumel couples show no appreciable advantages over the copper advance at low temperatures.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.

ALTRINCHAM BRANCH.

VISIT TO THE NATIONAL AIRCRAFT FACTORY (MESSRS. CROSSLEYS MOTORS LTD.), HEATON CHAPEL.

On Saturday afternoon, May 17th, some 30 members of the above Association—Altrincham Branch—visited the extensive aeroplane factory at Heaton Chapel, by the kind permission of Messrs. Crossleys Motors Ltd., and every member was highly pleased and interested; they also greatly appreciated the good feast unexpectedly provided afterwards by Messrs. Crossleys.

We were piloted round the works in two sections by Mr. C. Ball, representing the woodworking section of the Erecting Dept., and Mr. J. Brookes, of the Fitting Section. Both these gentlemen spared no pains in describing almost every detail of the two large types of aeroplanes the firm manufacture, also the numerous jigs, machines, and special plant that has been designed and put down exclusively for the manufacture of aircraft.

Two large aeroplanes of some 800 H.P., each of the D.H.10 type, were practically ready for "off." These machines have been extensively used in the war, and cannot help striking one as being, as the Yankees say, "absolutely it" as regards design and workmanship.

The works are laid out on the most up-to-date lines, everything modern; the main point which seems to have been borne in mind by Messrs. Crossleys one could not help observing at the outset, was the comfortable and healthy provision for the employees, perfect ventilation, light, and generally keeping an eye on the welfare of the workers.—Douglas Wilson, Technical Secretary, A. E. and S. D., Brier Cottage, Arthog Road, Hale.

Ministry of Munitions of War,
Whitehall Place, S.W.1,
23rd May, 1919.

ORDER.

Machine Tools, Wood-Working Machinery and Treadle Lathes.

With reference to the following Orders made by the Minister of Munitions, namely :—

The Machine Tool and Power Machinery Order, 1916, dated 28th August, 1916.

The Wood-Working Machinery Order, 1917, dated the 5th June, 1917.

The Treadle Lathes Order, 1918, dated the 15th April, 1918, the Minister of Munitions hereby orders as follows :—

(1) The operation of the said Orders is hereby suspended on and after the 23rd May, 1919, until further notice.

(2) Such suspension shall not affect the previous operation of the said Orders or any of them or the validity of any action taken thereunder or the liability to any penalty or punishment in respect of any contravention or failure to comply with the said Orders or any of them prior to such suspension or any proceeding or remedy in respect of such penalty or punishment.

(3) This Order may be cited as The Machine Tool, Wood-Working Machinery and Treadle Lathes (Suspension) Order, 1919.

Letters to the Editor.

COAL CONSERVATION.

Sirs,—May I call attention to the important statistics recently laid before the Royal Society of Arts by Sir Dugald Clerk in his paper on "The Distribution of Heat, Light and Power by Electricity and Gas," and urge that they be taken into careful consideration by the Government before any steps are taken to foster the use of electrical energy *as a heating agent*?

It is admitted that the provision of an ample and cheap supply of electrical energy for light and power is of great importance to our industries; and in regard to the waste of heat in the coal used for the generation of electricity for those purposes, it does not compare unfavourably with the manufacture of light and power at gas works. The consumer's choice of electricity or gas here depend solely on cost and suitability.

But the figures given by Sir Dugald Clerk (confirming as they do those of Professor J. W. Cobb in *The Edinburgh Review* for January last) make it clear that a most deplorable and avoidable waste of coal is entailed in the use of electricity as a source of heat. By the use of gas, this waste can be avoided, and at the same time the smoke nuisance in our towns and the drudgery in our homes reduced to a minimum.

Broadly, it has been shown that, to give equal heating or cooking service to the consumer, the use of electric energy as generated to-day entails the destruction of four tons of coal as against one ton at the gas works; and that even if the suggested "super" stations realised the most optimistic hopes of their advocates in regard to coal consumption the comparison would be as three to one in favour of gas.

Moreover, the use of coal for the raising of steam at electric generating stations means the absolute destruction of all the valuable chemicals recoverable at gas works as by-products, which have so largely contributed to our success in the war, and are vitally important to our industrial and scientific supremacy.

These facts and figures cannot be ignored. They show that the community must depend, in the future as in the past, on both the gas and the electrical industries of the country to play their respective parts in our industrial and domestic economy. Any idea of "doing everything by electricity" cannot be seriously entertained by practical men and women.

I could add much as to the practical drawbacks that would attend the proposed concentration of production in a few "super" stations, some of which were pointed out by the Chairman of the City of London Electric Lighting Company the other day; but my immediate object is to call attention to the gross waste of our national coal resources that would be entailed in the use of electricity *as a fuel*.—Yours faithfully,

D. Milne Watson,
President of The National Gas Council.

39, Victoria Street, London, S.W. 1.
26th April, 1919

Reviews.

BOILER FEED WATER. By Percy G. Jackson, F.I.C. London : Charles Griffin and Co. Ltd., Exeter Street, Strand, W.C.2. 4s. 6d. net.

There is a considerable amount of informative matter within the covers of the above work, and one might say it were possible to expand every single chapter into a book of similar size. If anything, Mr. Jackson has erred on the side of brevity. This is a book that power users will find of interest, but it is hardly one that provides them with the guide to everyday practice that they often need. In large concerns, where a laboratory is provided, much use will no doubt be made of the many years' experience Mr. Jackson publishes. There is, however, much that power users will do well to consider, and such chapters as that on "Softening" and "Selection of Softening Plants" are valuable and instructive. As we said earlier, much matter is contained in a small space, and in these strenuous times the book should have a welcome from a large body of power users.

Publications.

Messrs. Holdsworth and Sons Ltd., Croft Boiler Works, Leeds Road, Bradford, have forwarded to us a copy of their boiler catalogue. This includes details, specifications and illustrations of Cornish, Lancashire and Yorkshire Boilers made by the firm. The Yorkshire Boiler which is claimed to embody the latest principles in boiler construction can now be fitted with withdrawable furnaces. It is stated that a Yorkshire Boiler 24 ft. long will give the same evaporation for 9 cwts. of coal as a 30 ft. Lancashire will give for 10 cwts., diameters of boilers being equal, or working with equal chimney draught the Yorkshire will give 15 per cent greater evaporation per hour, maintaining equal evaporation per pound of coal burned. Messrs. Holdsworth also manufacture vertical boilers, oil separators, tanks, a patent feed-water diffuser, induced draught plant, etc

Patent Applications.

APPLICATIONS FOR PATENTS.

Ash, W. M. Vacy-. Carburettors or vaporisers for internal-combustion engines. 8,470. April 4th.
Bergasse, P. H. Two-stroke internal-combustion engines. 7,998. March 31st.
Blandy, S. H. B. (Liddelow). Belt-connectors. 8,105. Mar. 31st.
Brooks, S. Lancashire, etc., steam-boilers, and flue walls thereof. 8,007. Mar. 31st.
Cook, C. Internal-combustion engines, etc. 8,018. Mar. 31st.
Cruyt, L. C. System of superheating steam from boilers. 8,319. April 2nd.
Hicks, T. Superheater for heating feed-water for steam-boilers. 7,982. Mar. 31st.
Hill, T. Expansion flue joints for steam-boilers, etc. 8,006. Mar. 31st.
Jack, J. W. Gas-turbine. 8,095. Mar. 31st.
Lagersten, A. Water-cooled cylinders of internal-combustion engines. 8,049. Mar. 31st.
Leek, A. E. Flexible metallic packing for engines, compressors, etc. 8,410. April 3rd.
Liddelow, C. C. W. Belt-connectors. 8,105. Mar. 31st.
Morison, D. B. Steam-condensing plant. 8,565. April 4th.
Morison, D. B. Preventing absorption of air by boiler feed-water, etc. 8,566. April 4th.
O'Shea, S. C. Two-stroke internal-combustion engines. 8,547. April 4th.
Savage, G. H. Universal joints for coupling of shafts, etc. 8,087. Mar. 31st.
Sheppee, F. H. Lubrication systems. 8,342. April 2nd
Spence, W. L. Combination worm gearing. 8,363. April 3rd.
Warrington, E. Steam-boilers. 8,496. April 4th
Weir, G. and J. Packings for rotary shafts. 8,583. April 4th.
Arnott, F. H. Carburettors for internal-combustion engines. 10,125. April 23rd.
Bettinger, M. Valve-gear for internal-combustion engines. 10,208. April 24th.
Coleman, C. J. Power-transmitting systems. 10,373. April 25th.
Hall G. N. Belt-fasteners. 9,945. April 22nd.
Harrison, W. Means of vaporising fuel for internal-combustion engines. 10,419. April 26th.
Hopkinson and Co., J. Stop valves. 10,166. 10,178. April 23rd.
Hopkinson and Co., J. Steam-traps. 10,405. April 26th.
Kraft, H. P. Method of valve construction. 10,034. April 22nd. (United States April 18th, 1918.)
MacNicoll, D. Engine stop-gear. 10,118. April 23rd.
Mills, F. B. Steam-traps. 10,405. April 26th.
Wainwright, S. A. Internal-combustion engine. 10,236. April 24th.
Akt.-Ges. Brown, Boveri, et Cie. Driving auxiliary machines in steam-power installations. 11,429. May 7th. (Switzerland, Nov. 20th, 1918.)
Bateman, F. Internal-combustion engine crank chambers. 11,152. May 5th.
Berriman, A. E. Fuel systems for internal-combustion engines for motor-vehicles, etc., 11,521. May 8th.
Bollins, F. E. Internal-combustion engines. 11117. May 5th.
Chadwick, T. Turbines and stationary engines. 11,467. May 8th.
Dawson, G. G. Piston rings, etc. 11,636. May 9th.
Eyre, V. W. Internal-combustion engines. 11,411. May 7th.
Forsyth, A. G. Cooling-pistons of internal-combustion engines 11,534. May 8th.
Goss H. W. Internal-combustion engines. 11,716. May 10th.
Hershaw, H. Internal-combustion engines. 11,233. May 6th.
Howe, R. Internal-combustion engines, etc. 11,392. May 7th.
Leblanc, M. A. Apparatus for indicating operation of ignition in internal-combustion engines. 11,188. May 5th. (France, Feb. 5th, 1918.)
O'Donnell, J. P. Heating feed-water for locomotive, etc., boilers. 11,571. May 8th.
Palmer, E. V. Grease-cup lubricators, and manufacture of same. 11,252. May 6th.
Ramsden, B. (legal representative of A. Ramsden). Smoke-consuming furnace. 11,257. May 6th.
Randall, C. R. J. Cleaner for tubes of water-tube boilers. 11,537. May 8th.
Shire, L. G. W. Flexible couplings. 11,136. May 5th.
Troup, J. D. Packing for pistons, etc. 11,402. May 7th.
Verschueren, B. Boilers or water-heaters for central heating systems, etc. 11,365. May 7th.
Zephyr Carburettors, Ltd. Carburettors for internal-combustion engines. 11,522. May 8th.

COMPLETE SPECIFICATIONS ACCEPTED.

The number at the end of each paragraph is that under which the Specification will be printed and abridged, and all subsequent proceedings will be taken.

1916.

14,023.—Siddeley, J. D. Internal-combustion engines. Oct. 3rd. 1916.—126,008.
15,084.—Weir, G. and J., and Weir, W. Heating of boiler feed-water and its treatment with a view to preventing corrosion in the boilers. Oct. 24th, 1916.—126,014.
16,820.—Ricardo, H. R. Pistons for internal-combustion engines. Nov. 23rd, 1916. (Addition to 17,953/15.)—126,061.

1918.

5,273.—Nogrady, A. T. Differential gearing. Mar. 26th, 1918.—124,563.
5,429.—Read T. J., and Read, W. J. Carburettors for internal-combustion engines. Mar. 28th, 1918.—124,579.
6,202. Huelin, J. W. Means for preventing or consuming smoke in furnaces. April 11th, 1918.—124,603.
6,208.—Spencer, A. Steam superheaters of the multiple smoke or fire tube type. April 11th, 1918.—124,604.
7,766.—Deam, J. Piston-rod packings and the like. May 9th, 1918.—124,623.
8,370. Kane, W. H., and McClements, T. Cooling the cylinders of internal-combustion engines. May 21st, 1918.—124,626.
10,399. Briggs, J. C. Pumps. June 24th, 1918.—124,649.
4,537. Ross, W. Centrifugal pumps. Mar. 14th, 1918.—125,488.
6,261. Parks, H. S. Apparatus for indicating at a distance the level of water or other liquid in steam boilers and the like. April 12th, 1917.—114,851.
6,804. Smallwood, A. Furnaces. April 23rd, 1918.—125,515.
7,833. Barrett, A. N. Means for varying the volume of the compression space in any internal-combustion engine. May 10th, 1918.—126,155.
7,965. Smith, V. Water-tube boilers. May 13th, 1918.—126,159.
8,142.—Hawthorn, Leslie and Co., R. and W., and Armstrong, R. B. Water-tube steam-boilers. May 15th, 1918.—126,168.
8,662.—Hagemeister, J. J. Starting internal-combustion engines. May 24th, 1918.—126,182.
10,296.—Norton, J. L., and Norton Motors Ltd. Device for relieving compression in internal-combustion engines. June 22nd, 1918.—126,200.

1919.

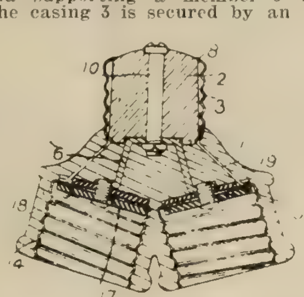
762.—Fernstedt, A. A. Reversing-gearing. Jan. 25th, 1918—122,634.
2,556.—Read, T. J., and Read, W. J. Carburettors for internal-combustion engines. Mar. 28th, 1918. (Divided application on 5,429/18.)—124,700.
3,262.—Aktiebolaget Svenska Kullager-fabriken. Ball-cages for radial ball-bearings. Feb. 14th, 1918.—123,318.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

ELECTRIC PLUG CONNECTORS.

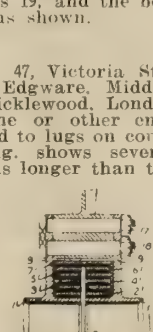
119,988.—H. FAIRBROTHER, 30, Ludgate Hill, London.—Ile, W., 210, Adelaide St. West, Toronto, Canada.—Mar. 9th, 1918.—An electric plug connector comprises a porcelain block 2 with a screw-threaded metal casing 3 and a central bolt 10 passing through a hole in the porcelain and supporting a member 6 with downwardly turned arms. The casing 3 is secured by an inturned flange 8



at the upper end, and by indenting the lower end into recesses in the porcelain. Threaded sockets 14 of spun sheet metal are provided at their upper ends with inturned flanges which are held between insulating discs 17, 18 secured to the member 6 by central contacts 13. The sockets 14 are connected to the casing 3 by metal strips 19, and the body 1 of the connector is then moulded in place as shown.

CONNECTING-RODS.

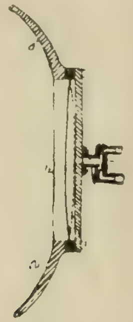
120,057.—G. H. THOMAS, 47, Victoria Street, Westminster, G. DE HAVILLAND, Woodcote, Edgware, Middlesex, and A. H. WILDE, 101, Melrose Avenue, Cricklewood, London.—Aug. 24th, 1917.—In a radial-cylinder aeroplane or other engine or pump, the connecting-rods are attached to lugs on concentric rings surrounding the crank-pin. The fig. shows seven concentric rings 1^1—7^1. The innermost ring 1^1 is longer than the others, and the outer-



most ring 7^1 is in one piece, while the other rings are in halves, the space 8 between the halves serving for the passage of lubricant, which is supplied through a passage in the crank-pin. A connecting-rod 1 is secured by bolts 17, 18 to lugs 9 on the ring 1^1, the other connecting-rods 2 being secured by bolts 19, 20 to lugs 13 on the other rings. The inner surfaces of the rings are lined with anti-friction metal.

INTERNAL-COMBUSTION ENGINES.

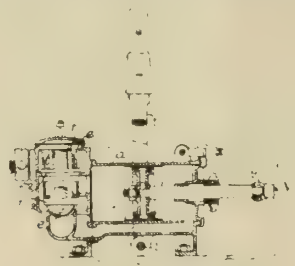
120,071.—T. MCCLEMENTS, 15, Cuba Street, Belfast, and W. H. KANE, Larne Foundry, Larne, Ireland. Oct. 16th, 1917. A fuel or lubricating pump *c* is worked by the pulsations of air in the



crank chamber *a* acting upon a diaphragm *b* which may or may not carry a plunger. The pump is controlled by the governor which adjusts the quantity of air admitted to the crank chamber.

RECIPROCATING PUMPS.

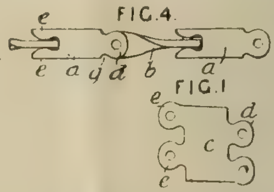
120,089.—J. W. RESTLER, Savoy Court, Strand, London.—Oct. 25th, 1917.—A hand-actuated portable double-acting pump comprises a barrel *a* mounted on a base *k*, each end communicating with a separate set of suction and delivery valves *e*, *e1* arranged at one



end of the barrel. The valves are enclosed in a cage *f*, *f1*, with which the delivery valve seat *f2* is integral, so that, by removing the cage, the suction valve is made accessible. The pump is actuated by a forked lever *i* pivoted at *i1* and connected by links to a cross-hed *g* on the piston rod. In a single-acting pump, only one set of valves is used and the opposite end of the barrel may be open. In a modification, the barrel is vertical and the two sets of valves are arranged at one side of the pump.

FLEXIBLE SHAFTS.

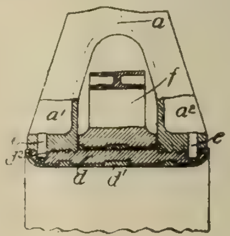
120,151.—J. F. MONNOT, 1, King Street, St. James', London.—(E. Seignol, 12, the Avenue de Madrid, Neuilly-sur-Seine, Paris.)—Jan.



19th, 1918.—In flexible shafts for driving speedometers, taximeters, etc., of the kind comprising links pivoted together so as to be flexible in two directions at right-angle, the links *a* are formed from a sheet-metal blank *c*, Fig. 1, bent to form a hollow cylinder and so that the gaps *g* between the pairs of lugs *d*, *e* lie at right-angles to receive the ends of the links *b*. The links *b* are formed of sheet metal and are twisted so that their ends lie at right-angles to each other.

CONNECTING-RODS.

120,174.—F. H. ROYCE, and ROLLS-ROYCE LTD., Nightingale Road, Osmaston, Derbyshire.—May 2nd, 1918.—In an engine of the V type having one connecting-rod *f* bearing on a bush *d* secured in



the forked end *a1*, *a2* of the other connecting-rod *a*, springing apart of the ends *a1*, *a2* is prevented by means of engaging grooves and projections *d2* formed on the bush *d*, and in the ends *a1*, *a2* and their caps. The bush is formed in halves, is positioned by dowel pins *e*, and has a white-metal lining *d1*.

INDEX TO ADVERTISERS.

[When enquiring of Advertisers will readers kindly make a "special point" of mentioning THE INDUSTRIAL ENGINEER.]

THE

Industrial Engineer.

VOL. VII.] JULY 8TH, 1919. [No. 186.

The Industrial Engineer.

A PRACTICAL MAGAZINE FOR ENGINEERS AND POWER USERS.

Published twice monthly, on the 8th and 22nd days, respectively.

All communications intended for insertion in the INDUSTRIAL ENGINEER, *or relating to Editorial matters, should be sent addressed to "The Editor," at our Office,* 121, *DEANSGATE, MANCHESTER, and must be accompanied by the name and address of the writer. Anonymous letters will not be noticed. We cannot undertake to return manuscripts or drawings, and correspondents are warned to keep copies.*

The Editor declines all responsibility in connection with the custody or return of unsolicited articles or papers sent to him.

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Communications relative to Advertising Rates should be addressed to the INDUSTRIAL ENGINEER, *Advertisement Department,* 121, *Deansgate, Manchester.*

CONTENTS.

EDITORIAL.

NATIONALISATION OR STATE OWNERSHIP.

COAL has loomed large in the public eye for a considerable time, and the shilly-shallying methods adopted during the past few years, the pandering to the workers in times of stress has had the inevitable result. There is a feeling rampant amongst all classes that one has only got to shriek loud enough these days to get what is required, and the labour unrest in every department of trade seems to indicate that the leaders consider the present reconstruction period the crucial moment for making demands. We do not oppose many of these demands, but we do agree with the more saner labour leaders in believing that the hysterical bellowings of the extremists are harmful to the integrity and supremacy of our industry, and directly hurtful to the workers they propose to benefit. Could there be anything more disappointing than the findings of the Coal Commission, although one with discernment could foresee the result? Could there be anything more deplorable than the present state of chaos in the cotton trade, when apparently there is hardly a creditable leader on either side, or, what is more hurtful to the industry throughout the Empire than the frothy mouthings of the "red-flaggers" so severely castigated by Mr. Ben Tillett the other day?

It may be truly stated that we are in a state of flux, but if there is to be evolved a solid concrete substance then agitation of this sort must cease and care taken to cast the result in a sensible mould. There is no doubt that the coming months will see a tremendous struggle between those in favour of coal nationalisation and those against. Nationalisation has been called a leap in the dark, and though we reiterate other writers, we are just as strongly of opinion as they are that if we are to take such a leap it must be taken of deliberate choice and with a clear conception of what we are doing and why we are doing it.

Conservation of our coal has been preached for some considerable time. There is at present before Parliament the Electricity Supply Money Resolution, which aims at providing twenty millions to reduce the cost and increase the supply of electricity. The consumer either of coal or electricity—or more generally energy—requires it at the lowest cost possible. This is essential to industry, and, moreover, it is just as essential that any disturbance in the supply should be avoided. Certainly we want to put to the best national use our national possession, but shall we secure this by nationalisation of our coal?

Both sides are against private ownership of minerals and the system of royalties as they at present exist. But the case for nationalisation rests upon very weak grounds, and it is, on the other hand, admitted that the results sought, the consumer's voice in the amount of coal to be produced, the reduction of competition as regards export, the transportation of the material, lack of capital, and bad management, can all be remedied without nationalisation. Therefore, why nationalise? has been asked. Restrictions on striking are proposed, and therefore one is compelled to believe that, even though the State does own the mines, we shall not be free from the bugbear of labour unrest, which is so detrimental to us as an industrial nation.

Surely we can hardly bring ourselves to believe, after all, the trouble that was experienced during those four and a half years we were all supposed to

be working for the State—some of us in more perilous positions than the industrial worker at home—will evaporate should the State take over the mines. All power-users look to a supply of coal of good quality in adequate quantities at a reasonable price, but there is no assurance that this will be forthcoming in any of the reports. There is a strong feeling, which we endorse, that "the nationalised mines are to be run in the interest of the miners, not of the community, and, if they are not, then all the trouble we have had before will recur."

And with a final word we will leave it. The miner will use nationalisation to his own interests and not for the nation. We shall gain nothing, and may stand to lose a great deal.

THE INDUSTRIAL SITUATION.

By Charles Gregory.

The Rights of the Employer.

In my previous articles it may be thought by many who have read them, that the writer was giving undue prominence to the claims of the workers, ignoring the rights of capital, and the side of the question dealing with the claims of the employers. I have no desire to do other than render justice to those claims, which are the genuine and inalienable rights of the employing classes. The paramount difficulty which presents itself at the outset is, what is a fair return upon capital invested in industrial and commercial concerns, and it is upon this point that very grave divergence of opinion is likely to occur.

Writing from personal experience, I should say that a strictly net return of 10 per cent is what might be considered a fair and reasonable profit on such investments as those referred to. If the investor in such realises the total amount of his investment, by means of dividends in 10 years' time, he has not very much ground for complaint.

A Reasonable Profit.

What galls the intelligent worker, however, is the fact that he may be engaged working for a firm paying 20 per cent dividends, but his wages are no better than those of his fellow-workman engaged in the same industry, but who happens to be working for a firm who are only paying 10 per cent dividends. The firm's prosperity is not reflected in his case by better wages, and he considers that he and his fellow-workmen, having contributed their share to the success attained, should receive a just proportion in the shape of higher wages than those employed by the less successful concern. In such a case the worker is inclined to think that extra effort upon his part is not likely to meet with a commensurate recompense.

Co-Partnership.

In this connection, I am well aware, it will be pointed out that the reason such conditions do not obtain is the fault of the trades union demand for a standard rate of pay. There is something to be said for this view of the case, but it should be remembered that the trades unions only fix the minimum rates to be paid, and that these are largely governed by the cost of living. Further, it generally follows that a decline of trade in any given industry is invariably followed by a decline of wages.

Profit sharing has been advocated as a solution of the wages' part of the problem, and in many instances it has brought about a better understanding as between employer and employed. An extension of the system of co-partnership has much to be said for it, as the existence of such a system, more than any other, pre-supposes and actually establishes community of interest between capital and labour. Such experiments will do more to create a right understanding than all the theoretical speeches that may be made on the subject of the interdependence and identity of interest that ought to exist between the two primary essentials to industry.

Co-operation of Labour in Control.

Much has been spoken, as well as written, on the subject of labour having a share in the control and direction of industrial enterprises. Here again, we find great difficulties present themselves. The first and probably greatest one will be the question of who shall nominate or elect the workers' representatives on the Board of Management. If the worker director is chosen by the firm, irrespective it may be of his undoubted fitness and capacity, the workmen may take it that such choice deprives them of a voice in the selection of such, and they will probably suggest that the individual chosen is to be used as a catspaw by the other dirctors, and that owing to his seat on the Board he will naturally be averse to taking any action they may deprecate.

The Danger of Popular Election.

On the other hand, popular election by the general body of workers in an establishment may result in the election of an individual, clever in other respects, but possessing only the very crudest notions of the methods by which a successful business concern must be conducted. Such a one would be a hindrance rather than a help in the task of developing a firm's trade or resources.

Anyone who has had experience where very large bodies of men are employed will agree with me when I claim that the probability would be that the workers in such a case would be inclined to elect the most fluent talker in their ranks, and nine times out of ten he would prove a very inefficient business man.

Clever business men are like poets, they are born, not made. The class of man required by the workers in such a case is the one who will on appointment consider himself as responsible for the good government and successful working of the undertaking as any of his co-directors, and who will realise that he is there not merely with a watching brief on behalf of his shopmates, but that he is there to give the best of his talent and ability to ensuring the success of the concern as a whole.

It should not be difficult for the management of an establishment, after careful scrutiny, to spot the right sort of man, but in selecting such, care must be taken to ensure his remaining in close touch with his fellow-workers. This difficulty disposed of, it then remains for the management to take the whole mass of the workers more into their confidence than has hitherto been the case. It is a true saying, though a trite one, that "Confidence begets confidence."

A few years ago the writer was one of a deputation which waited upon the manager of one of the largest engineering concerns in the Manchester district with a view to the rectification of what was undoubtedly a genuine grievance. At the interview which took place, the manager, for a change, took the deputation into his confidence, detailing the facts and circumstances which had caused the trouble, proving clearly that it was the force of circumstances and not intention that was responsible for the position which had come about. After a short exchange of views, a satisfactory basis of agreement was found, with an ultimate result pleasing to everybody concerned and, moreover, lasting in its effects. I merely mention this in passing to show that an exchange of confidences does very much to clear the air, and breaks down the spirit of armed neutrality, which is fatal to arriving at a right conclusion.

The Workman in Ignorance.

Until quite recent times it seems to have been the accepted policy of the employing class to keep the workman in profound ignorance of all that concerns commercialism, and yet, when as a result of this want of knowledge the worker kicks the traces, they are the very people who complain and rant about his ignorance of the difficulties which capital is called upon to encounter. This is hardly playing the game. Nothing is ever lost by straight talk and upright dealing, and the time has arrived when all the cards must be placed upon the table.

The problem of industrial reconstruction is of paramount importance to us, both as individuals, and as a community, and the sooner we get to work on the matter the better it will be for us. A policy of do nothing and drift is unnatural, for if we are not progressing, we are surely doing the opposite. In this world there is no such thing as standing still, and if we are not going forward, then we are slipping backward.

I would suggest to those whose interests are bound up in the maintenance of our supremacy as a commercial power that a solution of the present industrial problems must be found, and with as little delay as possible. Such solutions as are required to meet the emergency will not be found by means of Commissions, royal or otherwise, but they may be found as the result of a properly-organised and rightly-constituted conference.

Personally, I have little faith in the commercial acumen of a Government that hastens to release the control on horse racing, but maintains it on the raw materials vitally necessary to our staple industries.

Amusement not of Primary Importance.

One might be pardoned for thinking that it was the amusement of the people which was of primary importance and not the general well-being of the community as a whole. Already some people are inclined to find a sinister significance in this instance of racing. They claim that with the revival of racing there will be a consequent revival of gambling, and that if the workers are kept guessing what will win a classic race, they will have no time to study matters which affect them more closely, and as a result they will become an easy prey to those who are desirous of exploiting them. The evidence certainly tends that way, but while such a state of things may be to the interest and profit of a few, the best interests of both employers and workmen will languish.

While the workers have their gaze riveted on Epsom, they are likely to miss much that is going on at Paris and elsewhere, and while they are wondering what will win the Manchester Cup, they are not likely to bother about the true interests of industry.

A WORD OF ADVICE TO JUNIOR DRAUGHTSMEN.

By Robt. W. Bloomer.

This little talk is intended to be helpful to those younger members of the profession who have the ambition to become capable and efficient draughtsmen.

A working drawing is a composition of geometry, mechanics, and mathematics—three exact sciences—so make your draughtsmanship an exact science. Remember that every line on a drawing means something; if you have any lines on yours that don't, you are wasting the firm's pencils, unless you use your own. Make your drawing so that it can be easily read. If a man comes round to your board and, after ten seconds' scrutiny, tells you there is nothing in the job, you may regard it as a compliment to your powers of simplification.

If you don't know anything about a thing, say so; you will be immeasurably nearer knowledge by the confession. Not knowing a fact is excusable; not desiring to know is highly culpable. Don't be afraid to ask the opinion of your fellow-draughtsmen on a certain point, even if they are younger or less experienced than yourself, everyone in a crowd does not get the same view of an object. If your chief's views differ from your own, work to his instructions by all means; your idea may be better than his, though it is more probable he has tried your way ten years ago. Learn from the mistakes of others, and especially from your own. Don't think a job is beneath you; often the man who talks like this is beneath the job. Copy the work and style of others if it commends itself to you. Take your work seriously. A man's work is an *expression of himself*, do it as such. Be neat, it is impudence to instruct the man in the shop to work to *mils*. if you cannot draw to an eighth of an inch yourself.

Try to develop your judgment and cultivate a good sense of proportion; remember the best engineer is he who can get most work out of a given quantity of material. Don't put in $\frac{7}{8}$ in. metal if $\frac{5}{8}$ in. is sufficient, and justify yourself by the statement that $\frac{7}{8}$ in. is stronger—you may assume your chief knows this. Put cost and efficiency first and elegance afterwards. You may safely increase the cost of an article 2s. 6d. if it will increase the efficiency 10s Never make an addition which reverses these values.

Don't put in 3-in. diameter pipe if a 2-in. will suffice. On the other hand, if the ultimate demand of the service would justify a 7 in. bore, don't use a 6-in. with the mental reservation that customers can make the change-over at a later date.

When designing be conscientious, endeavour to spend your employer's, and also the client's, money as if it were your own.

Cultivate an enquiring mind and your powers of observation. Don't enter into competition with the clock and be such a "sport" as to always let the clock win. Take an intelligent interest in all you do, and endeavour to build up a reputation for accuracy and thoroughness.

I have a little nephew of the mature age of six. The other day he confided to me that when he grew up he was not going to be a draughtsman, he was going to be a *proper engineer*! A stray shaft I will admit, still I will leave it with you.

THE HARDENING OF STEEL FROM THE COMMERCIAL ASPECT.

It has been pointed out that the Automatic and Electric Furnace Ltd.'s monthly, *Heat Treatment Bulletin*, deals entirely with the technical side of the business, and that the Company have failed to recognise the commercial managers' desire to grasp the benefits to be derived and the comparative costs, etc., of installing and working the Wild-Barfield automatic hardening furnaces. In a series of short articles it is proposed to explain the commercial advantages, etc.

In the first instance, it is necessary to explain why the furnaces are automatic; and the reason why steel hardened by this process gives greater resistance to wear than steel hardened by the usual method.

It is a well-known physical law that carbon steel *loses* its magnetism exactly at the temperature at

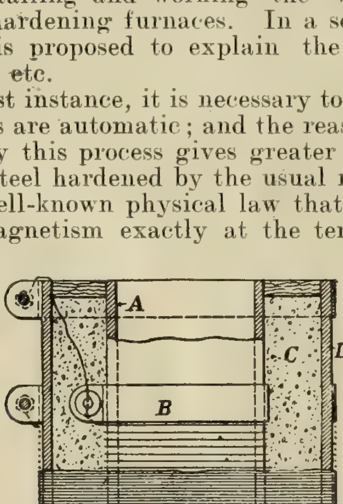


Fig. 1.

which it should be quenched in order to obtain the *finest possible grain*. This temperature depends entirely upon the amount of carbon in the steel. Under-heat your steel, and you have a poor article; over-heat it, and it is spoilt. Correctly heat it *every* time, and you have the highest grade of articles that it is possible to produce in steel, and a resistance to wear that cannot be equalled.

Reference to Fig. 1 shows a furnace pot A containing salt mixture, wound with an electric heating and magnetising coil B; C is a special heat-resisting powder, and the outside casing of the furnace D is wound with a coil of special enamelled copper wire E.

When an electric current is passed through the coil B, it renders the salt molten and magnetises any steel article placed in the furnace pot B. When the article reaches its non-magnetic point, a small current is automatically induced in the winding E, which causes a deflection on an instrument immediately notifying the operator that the best possible temperature for quenching has been reached. The best results can therefore *always* be arrived at irrespective of the carbon content of the steel.

The commercial advantages of this system may be summed up as follows:—Greater reliability of production, reduction of wastage, uniformity of results, use of unskilled labour, absence of fumes, no special ventilation required, low working and running costs, high efficiency of furnace.

Assuming that current is purchased at 1d. per unit and that a full 47-hour week is worked, the furnace being maintained hot through the night by passing through it a reduced current, the following table gives the cost of current per week and the output of treated steel:—

Diameter of furnace.	Pounds of steel per week.	Cost per week. £	s.	d.
2 in.	235	0	7	11
2 in.	352	0	10	6
4 in.	470	0	15	5
6 in.	845	1	7	4
8 in.	1410	2	3	9
12 in.	3050	5	0	0

The cost of labour is a variable item, but, generally speaking, one unskilled labourer, male or female, can conduct all operations necessary in connection with one furnace, whether it is a 2-in. or a 12-in. furnace.

The Company will be pleased to show the furnaces in operation at their London Works, 281-283, Gray's Inn Road, W.C.1, and to give assistance in any heat-treatment problems that may arise.

"MIDGET" SHORT SYSTEM FLOUR MILL.

[A. R. Tattersall and Co., 75, Mark Lane, London, E.C.]

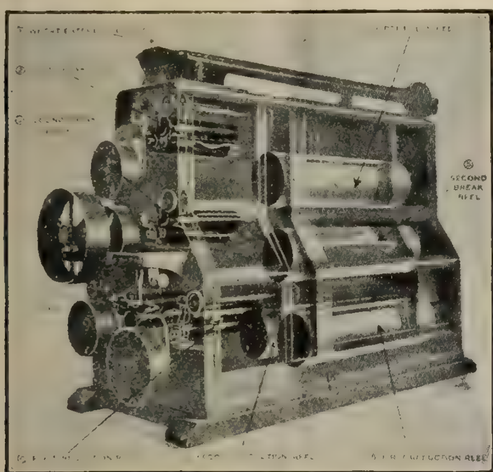
When one reads that over 1,500 "Midget" millers are at work throughout the world, it appears somewhat late in the day to publish any matter relative to it.

It is primarily intended for country millers, and has apparently enjoyed a very considerable success. It is a complete roller system plant contained in one frame and driven by one belt. It will grind from 200 lbs. to 600 lbs. of wheat per hour.

It can be operated by one man, and, its action being automatic, the time of this man is not fully occupied on one machine.

The roller section of the mill consists of two pairs

of fluted break rollers and two pairs of smooth reduction rollers. The movable roller of the pair is in each case adjusted by a patent double eccentric arrangement, which makes it impossible for the rollers, when once adjusted, to get out of parallel. The rollers can be accurately adjusted very readily. One hand-wheel eccentric adjusts each end of the roller, while a lever eccentric adjusts both ends at one and the same time. A patent vibrating sifter follows the first break rollers, the outsiftings of which pass to the flour dresser, the tails drop to the second break rollers. The flour-dressing section of the mill consists of four centrifugals. These dress



"Midget" Short System Flour Mill.

out the flour after rolling, drop the bran and sharps into separate sacks, and return the good residue to be re-rolled. In the whole machine only one elevator is used. This is built in and forms part of the machine.

The "Midgets" are sent out of the works completely fitted and adjusted. After a trial run they can easily be fixed down on a prepared floor and started off immediately.

WORKED EXAMPLES IN APPLIED MATHEMATICS

By G. E. Gittins, B.Sc. (Lond.).

(*Concluded from page 333.*)

Example 9.—A uniform chain has a mass of 2 lbs. per foot length, and the catenary in which it hangs has for equation $y = 10 \cosh \frac{x}{10}$; find the tension and the vertical component of the tension at a point for which $x = 25$ ft.

Solution.—We are given that $y = 10 \cosh \frac{x}{10}$; comparing this with the relation previously found, that is, $y = c \cosh \frac{x}{c}$, we notice that the parameter $c = 10$.

Now $T = w\,y = w\,c \cosh \frac{x}{c} = 20 \cosh \frac{25}{10} = 20 \cosh 2{\cdot}5$.

From the tables $\cosh 2{\cdot}5 = 6{\cdot}1323$, and hence total tension at the point considered $= 20 \times 6{\cdot}1323$ lbs. $= 122{\cdot}65$ lbs.

Also $\dfrac{\text{vertical component of tension}}{\text{total tension}} = \sin\phi$, where $\tan\phi$ is the slope of the curve at the point considered. Now we have that $y = c \cosh \frac{x}{c} = c \sec\phi$, and hence $\sec\phi = \cosh\frac{x}{c} = \cosh 2{\cdot}5$, from which (by tables) $\phi = 80^\circ\ 36'$, and hence $\sin\phi = {\cdot}9866$.

$$\begin{aligned} \therefore \text{ vertical component of tension} &= \text{total tension} \times \sin\phi \\ &= 122{\cdot}65 \text{ lbs.} \times {\cdot}9866 \\ &= 120 \text{ lbs.} \end{aligned}$$

Example 10.—In a common catenary show that if a point at arcual distance s from the vertex be at a height h above it, $\frac{(s^2 - h^2)}{h}$ is constant. Also show that if a chain of length $2\,l$ is suspended from two points in the same horizontal and has a sag h in the middle, then the span is $\frac{l^2 - h^2}{2} \log_e \left(\frac{l+h}{l-h}\right)$

Solution.—As previously proved, we have the relations—

$$(1)\quad y = c \sec\phi.$$
$$(2)\quad s = c \tan\phi.$$

Now the sag at any point is obviously

$$y - c = c\,(\sec\phi - 1) = h;$$

$$\therefore \frac{h}{c} = \sec\phi - 1 \text{ or } \frac{h+c}{c} = \sec\phi. \quad \text{Also}$$

$\sec^2\phi = 1 + \tan^2\phi = 1 + \frac{s^2}{c^2}$ from (1), and therefore $\frac{(h+c)^2}{c^2} = \sec^2\phi = 1 + \frac{s^2}{c^2}$ or $(h+c)^2 = c^2 + s^2$; that is,

$$\frac{s^2 - h^2}{h} = 2\,c. \quad \ldots\ldots\ldots\ldots\ldots\ \text{I.}$$

Since c is the parameter, this shows that $\frac{s^2 - h^2}{h}$ is constant.

For the second part of the question use

$$s = c \sinh \frac{x}{c}$$

or

$$\sinh \frac{x}{c} = \frac{s}{c}.$$

Putting $s = l$ and writing $\sinh \frac{x}{c} = \frac{e^{\frac{x}{c}} - e^{-\frac{x}{c}}}{2}$ we get

$$e^{\frac{x}{c}} - e^{-\frac{x}{c}} = \frac{2l}{c} \text{ or } e^{\frac{2x}{c}} - \frac{2\,l}{c} e^{\frac{x}{c}} - 1 = 0.$$

Solving

$$e^{\frac{x}{c}} = \frac{\frac{2\,l}{c} \pm \sqrt{\frac{4\,l^2}{c^2} + 4}}{2}$$

or

$$e^{\frac{x}{c}} = \frac{l + \sqrt{l^2 + c^2}}{c}$$

where the positive sign is taken, since $e^{\frac{x}{c}}$ is positive. Taking the exponential value we get

$$\frac{x}{c} = \log_e \left\{ \frac{l + \sqrt{l^2 + c^2}}{c} \right\};$$

consequently $2\,x = 2\,c \log_e \left\{ \frac{l + \sqrt{l^2 + c^2}}{c} \right\}$.

Now we have seen that $2c = \frac{l^2 - h^2}{h}$ and inserting this value we get

$$2x = \frac{l^2 - h^2}{h}\log_e\left\{\frac{2hl + l^2 + h^2}{(l^2 - h^2)}\right\} = \frac{l^2 - h^2}{h}\log_e\frac{(l+h)^2}{(l^2 - h^2)}$$

that is, the span

$$2x = \frac{l^2 - h^2}{h}\log_e\frac{(l+h)}{l-h}.$$

Example 11.—A flexible endless chain hangs over a circular pulley of radius r so as to be in contact with the pulley for two-thirds of its circumference. Find the total length of the chain.

Solution.—Consider the length of the chain as composed of two curves—one, a circular arc embracing two-thirds of the pulley, and the second a catenary representing the part hanging free. Clearly the length of the circular portion is $\frac{4\pi r}{3}$.

The length of the semi-arc of the catenary portion is given by

$$s = c\sinh\frac{x}{c} = c\tan\phi.$$

Now, since the chain covers two-thirds of the circumference of the pulley, the tangent at the point of leaving makes with the X axis an angle of $\frac{\pi}{3}$ radians. Therefore, since $s = c\sinh\frac{x}{c} = c\tan\phi$,

we get $\sinh\frac{x}{c} = \tan\phi = \sqrt{3}$,

or $e^{\frac{x}{c}} - e^{-\frac{x}{c}} = 2\sqrt{3}$;

that is, $e^{\frac{2x}{c}} - 2\sqrt{3}\,e^{\frac{x}{c}} - 1 = 0$.

Solving,
$$e^{\frac{x}{c}} = \frac{2\sqrt{3} \pm 4}{2} = \sqrt{3} \pm 2$$

Clearly the positive sign must be taken, and

$$e^{\frac{x}{c}} = 2 + \sqrt{3}\cdot$$

that is, $\frac{x}{c} = \log_e(2 + \sqrt{3})$,

or $c = \frac{x}{\log_e(2 + \sqrt{3})}$.

Now x for the semi-span is equal to

$$r\cos 30 = \frac{\sqrt{3}\,r}{2}$$

$$\therefore c = \frac{\sqrt{3}\,r}{2\log_e(2 + \sqrt{3})}.$$

We also remember that $s = c\tan\phi = \sqrt{3}\,c$, hence

$$2s = \frac{2\sqrt{3}\times\sqrt{3}\,r}{2\log_e(2+\sqrt{3})} = \frac{3r}{\log_e(2+\sqrt{3})}$$

And total length of chain is

$$\frac{4\pi r}{3} + \frac{3r}{\log_e(2+\sqrt{3})} = r\left\{\frac{3}{\log(2+\sqrt{3})} + \frac{4\pi}{3}\right\}.$$

Example 12.—A uniform wire of length l hangs in a nearly flat catenary between two points distant a apart on the same level; show that approximately

$$\frac{l}{a} - 1 = \frac{1}{24}\left(\frac{a}{c}\right)^2.$$

Solution.—We here require a relation between l, a, and c. Now we have seen that $s = c\sinh\frac{x}{c}$, or writing $\frac{l}{2}$ for s and $\frac{a}{2}$ for x we get $\frac{l}{2} = c\sinh\frac{a}{2c}$.

Now
$$\sinh\frac{a}{2c} = \frac{e^{\frac{a}{2c}} - e^{-\frac{a}{2c}}}{2}$$

and
$$e^{\frac{a}{2c}} = 1 + \frac{a}{2c} + \frac{1}{\lfloor 2}\,\frac{a^2}{4c^2} + \frac{1}{\lfloor 3}\,\frac{a^3}{8c^3} + \dots$$

$$e^{-\frac{a}{2c}} = 1 - \frac{a}{2c} + \frac{1}{\lfloor 2}\,\frac{a^2}{4c^2} - \frac{1}{\lfloor 3}\,\frac{a^3}{8c^3} + \dots$$

$$\therefore \frac{e^{\frac{a}{2c}} - e^{-\frac{a}{ac}}}{2} = \sinh\frac{a}{2c} = \left(\frac{a}{2c} + \frac{1}{\lfloor 3}\,\frac{a^3}{8c^3}\cdots\right)$$

approximately.

$$\therefore \frac{l}{2} = c\sinh\frac{a}{2c} = c\left(\frac{a}{2c} + \frac{a^3}{48c^3} + \dots\right) = \frac{a}{2} + \frac{a^3}{48c^2};$$

that is,
$$\frac{l}{a} = 1 + \frac{1}{24}\cdot\frac{a^2}{c^2}$$

or finally $\left(\frac{l}{a} - 1\right) = \frac{1}{24}\left(\frac{a}{c}\right)^2$ which is the form required.

Example 13.—The horizontal tension in a telegraph wire is not to exceed the weight of 1,500 yds. of the wire, and the wire is to be carried in spans of 100 yds. each over a distance of 20 miles. Prove that the least length of the wire is nearly 20 ft. more than the 20 miles.

Solution.—From Example 12 we get that $\left(\frac{l}{a} - 1\right) = \frac{1}{24}\left(\frac{a}{c}\right)^2$. Also from Example 8, $T_o = wc$, and therefore $c = \frac{T_o}{w} = 1500$. Inserting the values in the expression above we find $\frac{l}{100} - 1 = \frac{1}{24}\left(\frac{100}{1500}\right)^2$,

$$\therefore l = \left(\frac{100}{14\times 225} + 100\right)\text{ yards.}$$

Hence the increase in length for a span of 100 yds. is $\frac{100}{24\times 225}$ yds., and for the spans to cover 20 miles the increase is $\frac{100}{24\times 225}\times 352$ yds., or 20 ft. nearly.

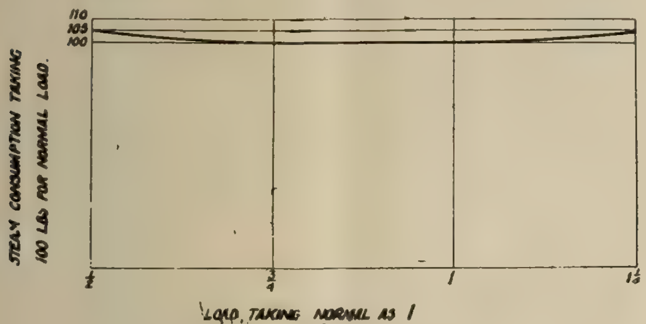
(Concluded.)

THE UNAFLOW STEAM ENGINE.

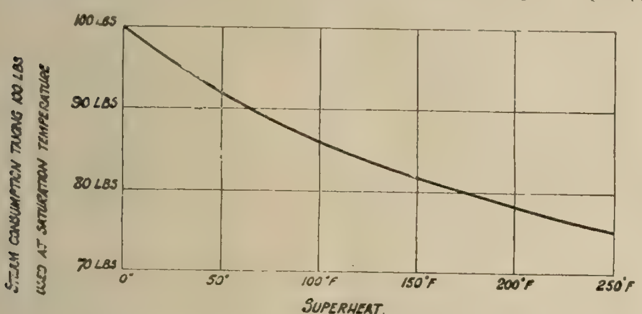
By D. H. Yates.

(*Continued from page 309.*)

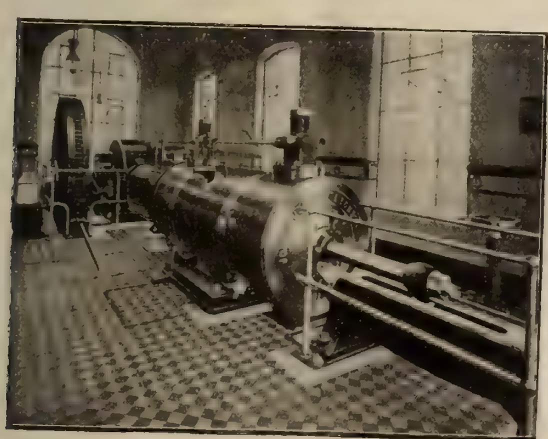
The steam consumption curve for a Unaflow engine varies very little with varying loads. This is illustrated by Fig. 21, which shows the same consumption for three-quarter load as for full load, with an increase of only 4 or 5 per cent for a quarter load or one and a quarter load. Owing to the small variation of steam consumption at widely varying loads, the Unaflow engine is very suitable for driving loads where these conditions are prevalent, such as rolling mills, paper mills, bleach works, etc., and also for cases where an engine is required to run lightly loaded perhaps for some years preparatory to extensions which would eventually make the load normal.



Unaflow Steam Engine.—Fig. 21.

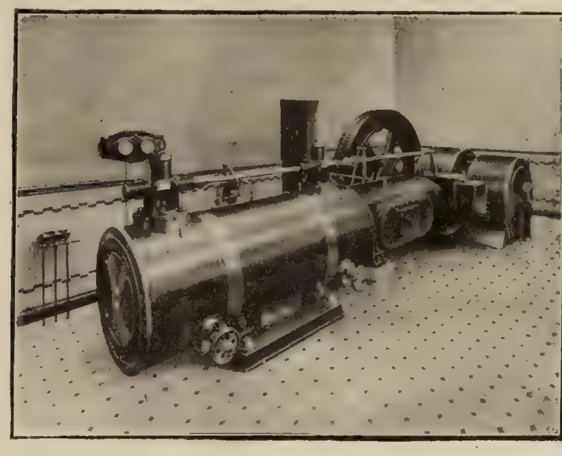


Unaflow Steam Engine.—Fig. 22.



Unaflow Steam Engine.—Fig. 23.

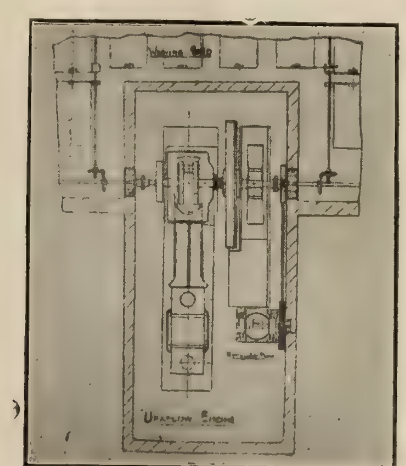
Superheating the steam reduces the steam consumption of an engine in a marked degree. This is illustrated by Fig. 22, which shows the gradual diminution in steam consumption of a Unaflow engine with increase in temperature of the steam. This is a typical curve, and these results are actually achieved in practice, but it must not be taken for granted that the reduction in steam consumption will show a corresponding reduction in the coal bill. Generally speaking, however, the superheating of steam does reduce coal consumption, and should certainly be adopted in the case of a Unaflow engine, which, owing to its small average cylinder temperature, is suitable for very high steam pressures and superheats.



Unaflow Steam Engine.—Fig. 24.

Advantages of the Unaflow Engine.

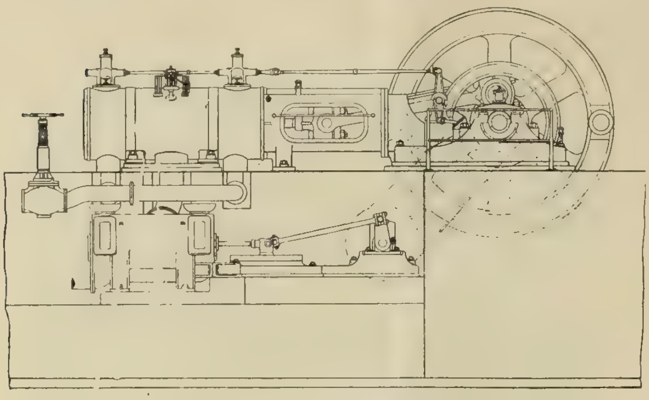
1. Simplicity of construction.
2. No exhaust valves and gear to get out of order, thus requiring little attention.
3. Very high mechanical efficiency.



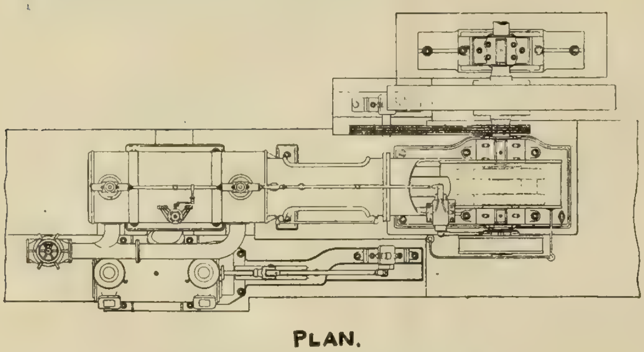
Unaflow Steam Engine.—Fig. 25.

4. Higher thermo-dynamic efficiency than other types of steam engine.
5. Small steam consumption.
6. Very suitable for high temperatures.
7. Small change in rate of steam consumption over a wide range of load.
8. Large capacity for overload.

9. Suitable for direct coupling to main line shafts, say, for weaving sheds.
10. Very sensitive to speed regulation, and very reliable.
11. Small cost of production and upkeep.



Elevation.



Plan.

Unaflow Steam Engine —Fig. 26.

12. Low oil consumption.
13. Comparatively small space occupied in relation to counterflow engines.
14. Reduction in cost of buildings and foundations, especially with direct drive.

With regard to (1) and (2) above, this is demonstrated by Figs. 23 to 26. Fig. 23 illustrates a Unaflow engine of 1,000 I.H.P. direct coupled to the main line shaft of a paper mill, running at 112 revolutions per minute. Fig. 24 illustrates a Unaflow engine of 550 I.H.P. also direct coupled to the main line shaft of a paper mill running at 138 revolutions per minute. Fig. 25 illustrates a Unaflow engine of 400 I.H.P. direct coupled to the main line shaft of a cotton mill running at 140 revolutions per minute, and Fig. 26 is a similar engine to Fig. 25 and drives a weaving shed.

(To be continued.)

THE WAGE PROBLEM IN INDUSTRY.

By W. L. Hichens
(Chairman of Cammell Laird and Co. Ltd.).

(Continued from page 343.)

Industrial Unrest.

So strong is the feeling of unrest in the industrial world to-day, that the view is gaining ground that ended. A cry has been raised that the wage system is a form of slavery which should not be tolerated in a free community. "Down with wage slavery" is a cry which appeals to the heart, if not to the head, of many a man and woman to-day. The only element of truth in the cry is that mankind is condemned to live by the sweat of its brow; for nobody can truthfully contend that labour has no voice in the determination of wages, the conditions of labour, the choice of employment, the essentials, in fact, of industrial life; its voice is at least as effective as any other, and it is absurd to compare the condition of the modern wage-earner with that of a serf under the feudal system. It would be a mistake, however, to ignore the strong opposition that exists to "wagery," and to imagine that it is merely the fantasy of disordered brains. Exaggerated it may be, misapplied even, but there must be some real injustice lurking unseen in the background to have given strength of late to this emotion which the present wage system arouses in the minds of many.

The root cause of the antagonism, I suggest, lies in the fear of capitalist domination. It is the dread lest ultimately capital may prove too strong for labour and enforce to the uttermost the doctrine by which industry is governed that might is right. The war with capital, in the minds of these people, is a war to the knife, and must be carried to the point of extermination—for there can be no compromise, given the right of capital (or indeed of labour) to exact whatever it is strong enough to demand. But even assuming (and I for one strongly dispute it) that the fear of capitalist domination is justified, will the alternative proposals of the syndicalists and guild socialists who denounce wage slavery provide a practicable solution? The guild socialists propose to divide the industries of the country into a number of watertight compartments, each of which will be run on democratic lines by the workers themselves, whilst they will all be co-ordinated by means of the guild congress. There would thus be a number of industrial states with wide and independent powers, but federated for common purposes. The members of each guild would be paid—not wages—but a share of the joint product of their labour. The essential feature of the scheme (for I must not weary you with details) is that each industry will be a monopoly controlled by the workers themselves. True, the guild socialist differs from the syndicalist in proposing joint committees of consumers' guilds and workers' guilds, of guild congress men and members of Parliament, but, failing agreement, the power of ultimate decision is always to rest with the guilds—the right to strike is to be their inviolable prerogative. Should we not, then, under the guild system merely have changed King Log for King Stork? Would the community be any better off under the régime of such a monopoly than it is at present? The competition between one manufacturer and another and between labour and capital at least has this advantage that the consumer reaps the benefit of the lowest possible prices. Competition is the very life-blood of the modern industrial system, and although its absurdities doubtless require trimming, it cannot be wholly eliminated without disastrous results. To substitute for it a series of democratic monopolies is to court certain destruction.

For it will be the workers themselves who determine the hours of work, the types of goods to be manufactured, the price to be paid. Better surely a balance of power between labour and capital even, as at present, than the domination of one or other. If the worker is right in his dread of the domination of the capitalist, the community is surely equally justified in hesitating to submit itself to the tender mercies of a number of democratic indusrtial monopolies.

Thus the attempt to abolish the wage system by the methods of syndicalism or guild socialism fails to safeguard the interests of the community as a whole, because it implies that each industry will be run in the interests of the workers and not of the community.

Profit-Sharing.

Another suggestion, however, which merits careful attention has been put forward as the solution of the wage problem. It is urged that, since the rivalry between capital and labour has led to disastrous consequences, the true solution lies in marrying the interests of the two by means of profit-sharing or co-partnership. At first sight the proposal is very alluring, for whilst assuring a reasonable wage to the workers and a reasonable return to capital as a first charge on the proceeds of each industry, it secures that the balance shall be fairly divided between the two.

Co-partnership.

But, although the principle of co-partnership is doubtless applicable in certain cases, there are, it seems to me, certain fatal objections which prevent its general adoption.

In the first place, if it is to succeed, the capital employed must be high in relation to the wages. If, for example, to assume an extreme case, the capital in any given business were £1,000 and the wages £100,000, it is obvious that, without gross profiteering, the share in the surplus profits accruing to labour would be insignificant. If, on the other hand, the capital were £100,000 and the wages only £1,000 the prospects of a substantial dividend to labour would be rosy.

In the second place there would be glaring inequalities amounting to injustice as between one business and another. A collier working on a rich mine would receive far more than his fellow-worker on a poor mine, although the type of work done by each and the hours of labour might be exactly the same. This would cause a rankling sense of injustice, and in the end probably men would pay a premium to work on the rich mine just as porters and head waiters in big hotels are said to pay a premium in consideration of the tips that they expect to receive. It is really unreasonable to expect that a worker in a struggling concern should be paid less than one engaged by a rich firm, and in actual practice I suspect that it will be found necessary for the less successful firms to guarantee a bonus equivalent to the share of the profits accruing to the workers in the more prosperous ventures. Otherwise a firm which had met with reverses would find that it could only attract the least efficient workers at a time when efficiency was most needed to save it; or it might even find that it was unable to obtain the necessary labour.

It would be easy to multiply the practical difficulties that would arise if co-partnership were adopted on a wide scale, but I will confine myself to one further point the importance of which cannot be ignored. The tendency of modern industry is towards big organisations, and this applies to the world of labour just as much as to capital. No doubt this movement has its drawbacks, but it promises even greater compensations in the direction of heightened efficiency, economy of production, and the greater stabilisation of employment.

Interchangeability of Labour.

On the side of labour big combinations are an advantage, not merely because they strengthen the bargaining power of the workers, but also because they break up the watertight compartments into which many small trades have drifted. Interchangeability of labour is an essential of modern industry for, owing to the changes in methods of manufacture which new mechanical inventions are daily introducing, work cannot be stereotyped in the hands of any given trade. The workers must be ready to change their methods and even their trades if we are to secure economy of production. Consequently, the demarcation disputes which have always been one of the bugbears of industry will tend to increase as our methods improve unless there is more elasticity as between one trade and another. It is really absurd that one trade should claim the privilege of punching a hole in a ship's plate while the prerogative of drilling a hole in the same plate belongs to another trade. This interchangeability can best be secured by broadening the basis of trade unions.

Similarly trusts and cartels, provided they are properly controlled, will play a greater part in securing increased efficiency and greater production.

If then the organisations of labour and capital expand, and in some industries become all-embracing, there is a real risk that under a co-partnership scheme the community may be exploited. If, for example, the coalminers and the coalowners were to form one big co-opartnership organisation, the interests of both might be satisfied; but the general public would suffer. In fact, fundamentally, the same objection applies to co-partnership as to the guild system or syndicalism, namely, that it assumes that industries are to be run primarily in the interest of those engaged in them, and not in the interest of the whole community.

I do not believe, therefore, that any satisfactory scheme can be devised for eliminating the wage system, save in exceptional cases which are of small moment in the consideration of the problem. If, then, there is no alternative to the wage system, what can be done to remove the objections that are brought against it? I do not propose to discuss here the relative merits of time rates, piece-work rates, and premium bonuses, partly because I should make too great a demand on your patience, and partly because none of them can solve the fundamental objection which is brought against the wage system —I mean the fear of capitalist domination. So long as industry is organised on the principle that the criterion of what either capital or labour are entitled to have is what their strength enables them to

acquire, so long as the keynote of industry is that might is right, each side will naturally fear domination by the other.

(*To be continued.*)

WATER POWERS IN GREAT BRITAIN.

(*Concluded from page 303.*)

INTERIM REPORT OF WATER-POWER RESOURCES COMMITTEE.

Bases of the Estimates.

The estimated costs of development are based upon pre-war contract prices with an addition of 50 per cent, which it is hoped will be ample to cover the post-war costs of works of this description. The costs are inclusive of all civil engineering and hydraulic works, power house and plant, and of reasonable compensation for rights and property that would have to be acquired to carry out the developments. Materials for the construction of light railways and hutments would be available from military stores, and the costs of such materials are included in the estimates. Each scheme will take approximately 2½ or 3 years to construct; the labour required on the sites during the first and third years respectively being indicated in the last column of the table.

It may be noted that while the development of some of the above schemes would involve a certain amount of interference with local amenities, the aspect of the countryside would also be improved, owing to the fact that poor ground now liable to flooding would be permanently submerged and the area of the lochs extended.

7. Although only preliminary surveys have been made on behalf of the Committee, the engineers employed for the purpose are of such high standing that the Committee feels that general reliance can be placed upon the reports furnished by them. Moreover, the Committee has corroborative evidence in support of some of the schemes, three of which have been thoroughly surveyed on former occasions, and their costs of construction carefully taken out.

A Sound Commercial Basis.

8. The surveys and estimates of the nine schemes give a total continuous power of 183,500 electrical H.P. at an average capital cost of £38.5 per effective electrical H.P. developed at the water-power stations.

After a careful consideration of the post-war prospects of developing power on a large scale by the most modern steam turbo-electric practice, the Committee has arrived at the conclusion that with similar conditions in regard to transmission and distribution, it would be possible for a water-power scheme of, say, 5,000 electrical H.P. or upwards to compete on an equality with the very best steam power station (assuming 12,500 British thermal units coal at 10s. per ton delivered), provided the cost of developing the water power did not exceed about £60 per effective electrical H.P. It will be seen, therefore, that the above schemes, individually and collectively, are well within the limiting cost for development on a sound financial basis. In the case of schemes of smaller size situated remotely from existing power facilities, a higher capital cost per effective electrical H.P. would be permissible if the power were to be used for local requirements.

Cost of Generation.

9. The Committee estimates that if the above schemes were fully developed and fully utilised, the average cost of the electrical energy generated, inclusive of all running expenses and capital charges, should not exceed 0.15 of a penny per unit at the water-power stations. It must be understood that such a cost would only hold in the event of the continuous use of practically the whole output by works situated near the power stations, *e.g.*, by electro-chemical or metallurgical works. For ordinary industrial demands of a less continuous character, the cost would, of necessity, be greater.

The Committee further estimates that the energy could be delivered into the industrial districts of Scotland at a cost which would be considerably lower than the present cost of electricity. The effects upon the districts would be markedly beneficial, smoke and dirt would be reduced, and a large quantity of coal would be saved or set free. (See paragraph 3.)

Effect on Local Industries and Population.

10. If some of the schemes were utilised for the alternative purposes indicated in par. (4) the establisment of local industries would attract a larger population, bring about the development of transport, and also would lead to increased agricultural and dairy production to support the larger population.

The Official Representative of the Scottish Board of Agriculture and other witnesses have drawn attention to the serious situation in regard to the diminishing population in many parts of Scotland. These water-power schemes, and there are many others in various parts of Scotland which the Committee is investigating—provide the means of promoting the resettlement of the people in or near their native location, and of bringing about developments in agriculture and dairying, and of railways or other transport facilities.

National Assets.

11. The Committee is unanimously of opinion that these potential water powers are to be regarded as national assets, and that any rights or property necessary for their utilisation should be acquired by the nation at reasonable and proper purchase costs.

The Committee is further of the opinion that the water powers should either be developed by the State, or leased to a public or commercial undertaking for a sufficient term of years to enable the lessees to redeem the large capital expenditure by means of a small annual sinking fund which will not add unduly to the cost of the available power. This matter is at present under investigation, and will be dealt with more fully in the final report of the Committee.

12. If some of the above water-power schemes are to be begun at once for the useful employment of labour in 1919, the only possible way appears to be for the Government to promote a short Bill giving the Board of Trade powers to acquire the necessary rights, and for the Board to instruct the engineers at once to make further surveys where such are necessary, to prepare plans and to take out quantities, so that actual construction could be begun in the early summer.

Probably only a few of the schemes would be selected for immediate development, and the Committee is prepared to advise upon this point.

Other British Water-Powers.

13. The Committee is in possession of further reports and estimates based upon surveys carried out in Scotland (Loch Broom area; also the area containing Lochs Glass, Morie, and Brora), and in North Wales, and promising schemes are indicated in each report. For example, there is a power in North Wales which is capable of developing 4,400 continuous electrical H.P. at an estimated capital cost of £41.8 per effective electrical H.P.

These reports are still under consideration, and the schemes will be dealt with in more detail in the Committee's final report.

14. Particulars have been submitted to the Committee of potential powers in the Lake District, in Devon and Cornwall, and elsewhere. A scheme for the utilisation of the tides in the River Severn has also been put forward. It presents a number of interesting features, and is being further investigated by the Committtee.

15. There appear to be numerous small water powers in many parts of the country, ranging from 100 electrical H.P. to perhaps 2,000 electrical H.P. These are at present running to waste, whereas in many cases they could be usefully developed either for mills or for local agricultural and village requirements. Alternatively, the powers could be developed in automatically-worked stations, which would deliver energy into a general electrical transmission network, or would serve to supplement existing coal-fired power stations. Water-power resources could thus be utilised in the same way as many sources of waste heat in this country.

The Committee is proceeding with investigations in these directions.

Principles of Development.

16. Official representatives of several English and Scottish Departments, and witnesses experienced or interested in water-power schemes, have given evidence dealing with the various claims that have to be reconciled in developing water powers, and with the general effects of such developments upon local industry, agriculture, fisheries, prevention of flooding, local amenities, and so forth.

Although these aspects of the enquiry are still under investigation, the Committee feels it necessary to make certain comments at the present stage.

Weights of Lengths of Rolled Steel Sections.

Beam 9 in. × 4 in. × 22 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	Ft.
0	..	1 3 24	3 3 20	5 3 16	7 3 12	9 3 8	11 3 4	13 3 0	15 2 24	17 2 20	0
1	0 0 22	2 0 18	4 0 14	6 0 10	8 0 6	10 0 2	11 3 26	13 3 22	15 3 10	17 3 14	1
2	0 1 16	2 1 12	4 1 8	6 1 4	8 1 0	10 0 24	12 0 20	14 0 16	16 0 12	18 0 8	2
3	0 2 10	2 2 6	4 2 2	6 1 26	8 1 22	10 1 18	12 1 14	14 1 10	16 1 6	18 1 2	3
4	0 3 4	2 3 0	4 2 24	6 2 20	8 2 16	10 2 12	12 2 8	14 2 4	16 2 0	18 1 24	4
5	0 3 26	2 3 22	4 3 18	6 3 14	8 3 10	10 3 6	12 3 2	14 2 26	16 2 22	18 2 18	5
6	1 0 20	3 0 16	5 0 12	7 0 8	9 0 4	11 0 0	12 3 24	14 3 20	16 3 16	18 3 12	6
7	1 1 14	3 1 10	5 1 6	7 1 2	9 0 26	11 0 22	13 0 18	15 0 14	17 0 10	19 0 6	7
8	1 2 8	3 2 4	5 2 0	7 1 24	9 1 20	11 1 16	13 1 12	15 1 8	17 1 4	19 1 0	8
9	1 3 2	3 2 26	5 2 22	7 2 18	9 2 14	11 2 10	13 2 6	15 2 2	17 1 26	19 1 22	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	0 1·83	0 3·36	0 5·50	0 7·33	0 9·17	0 11·00	0 12·83	0 14·67	0 16·50	0 18·34	0 20·17	0 22	

Weights of Lengths of Rolled Steel Sections.

Beam 9 in. × 4 in. × 22 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	0 19 2 16	1 19 1 4	2 18 3 20	3 18 2 8	4 18 0 24	5 17 3 12	6 17 2 0	7 17 0 16	8 16 3 4	0
10	1 3 24	1 1 2 12	2 1 1 0	3 0 3 16	4 0 2 4	5 0 0 20	5 19 3 8	6 19 1 24	7 19 0 12	8 18 3 0	10
20	3 3 20	1 3 2 8	2 3 0 24	3 2 3 12	4 2 2 0	5 2 0 16	6 1 3 4	7 1 1 20	8 1 0 8	9 0 2 24	20
30	5 3 16	1 5 2 4	2 5 0 20	3 4 3 8	4 4 1 24	5 4 0 12	6 3 3 0	7 3 1 16	8 3 0 4	9 2 2 20	30
40	7 3 12	1 7 2 0	2 7 0 16	3 6 3 4	4 6 1 20	5 6 0 8	6 5 2 24	7 5 1 12	8 5 0 0	9 4 2 16	40
50	9 3 8	1 9 1 24	2 9 0 12	3 8 3 0	4 8 1 16	5 8 0 4	6 7 2 20	7 7 1 8	8 6 3 24	9 6 2 12	50
60	11 3 4	1 11 1 20	2 11 0 8	3 10 2 24	4 10 1 12	5 10 0 0	6 9 2 16	7 9 1 4	8 8 3 20	9 8 2 8	60
70	13 3 0	1 13 1 16	2 13 0 4	3 12 2 20	4 12 1 8	5 11 3 24	6 11 2 12	7 11 1 0	8 10 3 16	9 10 2 4	70
80	15 2 24	1 15 1 12	2 15 0 0	3 14 2 16	4 14 1 4	5 13 3 20	6 13 2 8	7 13 0 24	8 12 3 12	9 12 2 0	80
90	17 2 20	1 17 1 8	2 16 3 24	3 16 2 12	4 16 1 0	5 15 3 16	6 15 2 4	7 15 0 20	8 14 3 8	9 14 1 24	90

Ft	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	Weight.
	9 16 1 20	19 12 3 12	29 9 1 4	39 5 2 24	49 2 0 16	58 18 2 8	68 15 0 0	78 11 1 20	88 7 3 12	98 4 1 4	

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Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 9in. × 4 in. × 23 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 0 6	4 0 12	6 0 18	8 0 24	10 1 2	12 1 8	14 1 14	16 1 20	0 18 1 26	0
1	0 0 23	2 1 1	4 1 7	6 1 13	8 1 19	10 1 25	12 2 3	14 2 9	16 2 15	0 18 2 21	1
2	0 1 18	2 1 24	4 2 2	6 2 8	8 2 14	10 2 20	12 2 26	14 3 4	16 3 10	0 18 3 16	2
3	0 2 13	2 2 19	4 2 25	6 3 3	8 3 9	10 3 15	12 3 21	14 3 27	17 0 5	0 19 0 11	3
4	0 3 8	2 3 14	4 3 20	6 3 26	9 0 4	10 0 10	13 0 16	15 0 22	17 1 0	0 19 1 6	4
5	1 0 3	3 0 9	5 0 15	7 0 21	9 0 27	11 1 5	13 1 11	15 1 17	17 1 23	0 19 2 1	5
6	1 0 26	3 1 4	5 1 10	7 1 16	9 1 22	11 2 0	13 2 6	15 2 12	17 2 18	0 19 2 24	6
7	1 1 21	3 1 27	5 2 5	7 2 11	9 2 17	11 2 23	13 3 1	15 3 7	17 3 13	0 19 3 19	7
8	1 2 16	3 2 22	5 3 0	7 3 6	9 3 12	11 3 18	13 3 24	16 0 2	18 0 8	1 0 0 14	8
9	1 3 11	3 3 17	5 3 23	8 0 1	10 0 7	12 0 13	14 0 19	16 0 25	18 1 3	1 0 1 9	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs. 1·91	lbs. 3·83	lbs. 5·75	lbs. 7·66	lbs. 9·58	lbs. 11·50	lbs. 13·41	lbs. 15·33	lbs. 17·25	lbs. 19·17	lbs. 21·08	lbs. 23	Weight.

Weights of Lengths of Rolled Steel Sections.

Beam 9in. × 4 in. × 23lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	1 0 2 4	2 1 0 8	3 1 2 12	4 2 0 16	5 2 2 20	6 3 0 24	7 3 3 0	8 4 1 4	9 4 3 8	0
10	2 0 6	1 2 2 10	2 3 0 14	3 3 2 18	4 4 0 22	5 4 2 26	6 5 1 2	7 5 3 6	8 6 1 10	9 6 3 14	10
20	4 0 12	1 4 2 16	2 5 0 20	3 5 2 24	4 6 1 0	5 6 3 4	6 7 1 8	7 7 3 12	8 8 1 16	9 8 3 20	20
30	6 0 18	1 6 2 22	2 7 0 26	3 7 3 2	4 8 1 6	5 8 3 10	6 9 1 14	7 9 3 18	8 10 1 22	9 10 3 26	30
40	8 0 24	1 8 3 0	2 9 1 4	3 9 3 8	4 10 1 12	5 10 3 16	6 11 1 20	7 11 3 24	8 12 2 0	9 13 0 4	40
50	10 1 2	1 10 3 6	2 11 1 10	3 11 3 14	4 12 1 18	5 12 3 22	6 13 1 26	7 14 0 2	8 14 2 6	9 15 0 10	50
60	12 1 8	1 12 3 12	2 13 1 16	3 13 3 20	4 14 1 24	5 15 0 0	6 15 2 4	7 16 0 8	8 16 2 12	9 17 0 16	60
70	14 1 14	1 15 3 18	2 15 1 22	3 15 3 26	4 16 2 2	5 17 0 6	6 17 2 10	7 18 0 14	8 18 2 18	9 19 6 22	70
80	16 1 20	1 17 3 24	2 17 2 0	3 18 0 4	4 18 2 8	5 19 0 12	6 19 2 16	8 0 0 20	9 0 2 24	10 1 1 0	80
90	18 1 26	1 19 0 2	2 19 2 6	4 0 0 10	5 0 2 14	6 1 0 18	7 1 2 22	8 2 0 26	9 2 3 2	10 3 1 6	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	10 5 1 2	20 10 2 4	30 16 0 8	41 1 1 20	51 6 3 4	61 12 0 16	71 17 2 0	82 2 3 12	92 8 0 24	102 13 2 8	

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Applications, with particulars of training and experience, are to be sent to the Clerk of the Metropolitan Water Board, 2, South Place, Finsbury, E.C. 2, endorsed "Civil Engineering Draughtsmen" or "Mechanical Draughtsmen."

WANTED, JUNIOR DRAUGHTSMAN; some experience in internal-combustion engines desired.—Apply R. A. Lister and Co. Ltd., Engine Department, Dursley.

ENGINEERS, DRAUGHTSMEN, &c.

WANTED, a Young CIVIL ENGINEER of good address (Public School man preferred) who has experience in roadmaking as well as some knowledge of mechanics and internal-combustion engines, to represent and travel on behalf of Messrs. Barford and Perkins Ltd., Motor Roller Works, Peterborough.

DRAUGHTSMAN for General Engineering work required.—Apply, stating age, experience and salary, to Abram Lyle and Sons Ltd., Plaistow Wharf, Victoria Docks, London, E 16.

DRAUGHTSMAN, having all-round practical experience in Fan Work, capable correspondent.—Apply in confidence, Managing Director, Standard Engineering Co. Ltd., Leicester.

ENGINEER, reliable, wanted immediately, to take charge of engines and steam-raising plant; applicants must state age, experience and wage required.—Apply W. S. Mallalieu, Jackson and Steeple Ltd., Riverside Mills, Stalybridge.

DRAUGHTSMAN and Junior; experienced ventilating, warming, humidifying. DRAUGHTSMAN, experienced in the design of air compresors, pumps, fans, etc.; state full details.—Address H. Smethurst and Son Ltd., Engineers, Hollinwood.

WANTED, immediately, highly-skilled TURNERS for heavy, medium, and [illegible] work; highly-skilled MARKER-OUT for good-class work; highly-skilled JIG and GAUGE MAKER.—Apply giving full particulars, experience, age, etc., the Brush Electrical Engineering Co., Loughborough.

DRAUGHTSMAN required for motor design, to draw out mechanical details of electrical motors. Good experience necessary. Should be able to make own calculations of strength of parts, bending moments and deflections of shafts, etc.—State age, experience and salary required to Harland and Wolff Ltd., Belfast.

TRADE ITEMS, NOTES, &c.

The Krupp Works in Munich have been sold to an American consortium, according to a Munich report in South German papers. In the Rhine districts, too, several industrial concerns have already passed into American hands.

An authoritative account of "Science and Industry in Canada" was presented in a paper read before the Royal Society of Arts in March last. The matter has now been published in brochure form, and the information given by Professor John Cunningham McLennan, O.B.E., etc., will be of immense interest to many. It is an extremely comprehensive survey and covers in concise form quite a wide field.

According to the British Embassy at Washington, Ulco, a new bearing metal, contains the following percentages: Lead, 97.6; barium, 1.6; calcium, 0.4; and iron, 0.1. Its hardness varies with the percentages of barium and calcium. Low lead (less than 98 per cent) is stated to give a hard metal; while a high percentage of lead, 98 to 99 per cent, with a comparatively low percentage of barium and calcium, will yield a softer metal.

The Times of Saturday announced that negotiations are understood to be far advanced for the acquisition of the National Ordnance Factory at Nottingham by Messrs. Cammell, Laird, and Co. Ltd., of Sheffield, Birkenhead, and Penistone. It is believed that the factory will be adapted to the manufacture of steel railway waggons of the most approved type, the need for these at present being acute. Not improbably the company may turn later to the manufacture of passenger coaches, but steel goods waggons are the object immediately in view. The enterprise, it is believed, should dovetail in admirably with Messrs. Cammell, Laird and Co.'s works at Sheffield, where springs, tyres, and other parts of the waggons could be built. It is not unlikely that when the transaction is carried through a new company allied with Messrs. Cammell, Laird, and Co. will be formed. The acquisition is in strict accordance with the principle of linking up the activities of the different departments of the company, which has been highly successful in the past.

Giant Oil Tanker Launched.—The "San Fernando," the latest addition to the fleet of the Eagle Oil Transport Co. Ltd., was successfully launched by Mrs. Clive Pearson—wife of the Hon. Clive Pearson, the Chairman of the Company—at the yards of Armstrong, Whitworth and Co. Ltd., Newcastle-on-Tyne, on Tuesday, May 22nd. The "San Fernando" is designed to carry over 18,000 tons deadweight on Lloyd's Summer Draft, and is one of the largest oil tankers afloat. She is 547 ft. in length, and has 12 oil cargo tanks, each of which is divided into separate compartments by a watertight centre bulkhead. The piping is so arranged that four different kinds of oil can be dealt with simultaneously; oil can also be transferred from the forward to the after cross bunker, with the necessary cross-over pipe on deck for taking oil fuel from the shore. The tanks at the sides of the expansion trunk are fitted with piping and valves so that the oil carried therein can be dealt with, apart from the oil in the main tanks.

Removing Plugs from Stop Cocks.—A plug sticking in a stop-cock is very awkward to deal with, and attempts to remove it not rarely result in breakage of the plug. A simple device which has proved useful in many cases has been adopted in the Pittsburg Laboratory of the United States Bureau of Mines, and is described in the April issue of the *Journal of Industrial and Chemical Engineering*, by Vernon C. Allison. It is simply a slab of hard wood, Maple or *lignum vitae*, into which a number of recesses have been cut of such shapes as to fit the ordinary sizes of plugs. Each recess consists of a slit, to be slipped over the neck of the plug, widening out inside into a circular hole to take the winged end of the plug. When hand-pressure is not sufficient for withdrawing the plug, the little device can be used in combination with a V-clamp or a vice. Allison mentions that he removed seven stop-cocks in four minutes, and that he has had no accidents so far.

17. From the broad review of the position, it is abundantly clear to the Committee that, in the development of the water-power resources of the United Kingdom, certain fundamental principles must be observed. For instance :—

(a) The whole of a watershed must be thoroughly studied and the fullest use made of its potential water power consistent with reasonable capital expenditure. A development which would only result in a part of the power being utilised should not be permitted, if the ultimate use of the whole available power is thereby prejudiced.

(b) Proper regard must be shown to the interests of domestic and trade water supplies, fisheries, the drainage of adjacent lands, canals, and inland navigation, and in certain cases to local amenities.

Neglect to give consideration to some of these requirements has been responsible in the past for failure in the promotion of some water-power schemes.

(c) A part of the available power must be reserved for use by the local population within the watershed, both for present requirements and also for prospective developments.

It is important to remember, however, that in the case of large water powers considerably in excess of local requirements, it would not, in general, be commercially practicable to ensure a cheap local supply of electricity unless the powers were developed to the maximum extent, and the bulk of the output utilised by an industry requiring practically a continuous supply throughout the year.

The Adjustment of Conflicting Interests.

18. There are two outstanding factors which have been prominent in arresting the wider development of water-power schemes on a large scale in this country, namely :—

(a) The costly, protracted, and inefficient system of obtaining the necessary authority by means of a Private Bill.

(b) The multiplicity of interests to be reconciled.

19. With regard to the former par. 18a, the Committee is of opinion that if the rights necessary for the development of all water powers above a certain size were secured by the State, as and when required, many of the difficulties experienced in the past would disappear, and preliminary waste of capital be obviated.

20. With regard to the question of multiplicity of interests there is no doubt whatever that the powers now vested in nemerous Departments, Boards, and other bodies concerned with different aspects of the water problem, require thorough revision and co-ordination. Many of the existing interests are or may be opponents of water-power developments, and if proper use is to be made of the valuable national asset represented by the potential water-power resources of the United Kingdom, the need of a simple, inexpensive and expeditious procedure for adjusting the claims of several interests is vital.

There is no question that the river system and its drainage area must be taken as a unit and dealt with as a whole in regard to all the water problems incidental thereto. In this connection the Committee desires to draw attention to the recommendations of Lord Elgin's Commission on Salmon Fisheries, 1902, which advocated, *inter alia*, the setting up of Watershed Boards under a Supreme Rivers Authority.

The Question of Control.

At the present moment the Committee does not express any opinion on the question whether unity of control could best be effected by extending and co-ordinating the powers now possessed by Departments, etc., or by the appointment of a new Statutory Authority or Authorities with executive or only co-ordinating and advisory powers. The Committee wishes, however, to emphasise the importance of the question, and to point out that it is a reconstruction problem which will undoubtedly require to be specially dealt with in the immediate future. The various aspects of the question are being examined in detail by the Committee. In addition, the development of water powers for electricity supply purposes has a close bearing upon the recommendations of the Board of Trade Committee on Electric Power Supply, and will require to be considered in relation to any legislative proposals to give effect to those recommendations.

Importance of Rainfall Records.

21. The Committee wishes to draw attention to the fact that the estimates of water power dealt with in this Report have only been made possible by the voluntary work of rainfall observers in all parts of the British Isles, which has been collected and discussed by the British Rainfall Organisation during the past 58 years. If the fullest use is to be made of the water-power resources of this country, it is essential that the work of observation should not only continue, but should be encouraged and developed.

Another branch of observation which has a vital bearing upon the question of water-power resources is the gauging of the flow of rivers. Great attention has been given to this subject in Canada and the United States, but only a small amount of observation has hitherto been carried out in this country.

Need for Hydro-Electrical Training.

22. Strong evidence has been submitted to the Committee regarding the lack of adequate training facilities in the Universities and Technical Institutes of the United Kingdom for young engineers wishing to enter the field of hydro-electric development. In view of the very large extension of water-power development that is practically certain to take place in the near future, both in this country, in the British Empire, and in other countries, the Committee consider it important in the interests of British industry, that steps should be taken to remedy this state of affairs.

The Committee recommends that its views on this matter be brought to the notice of the Minister of Education, the Secretary for Scotland, and the Chief Secretary for Ireland, and suggests that Government support should be given where necessary for the initiation of special lectureships and courses in the subject of Universities and Technical Institutes.—*Board of Trade Journal.*

(*Concluded.*)

ECONOMIES IN THE GENERATION AND USE OF STEAM.

By Sidney F. Walker, R.N., M.I.E.E., M.I.M.E.

(*Continued from page 312.*)

Some Advantages of Using Gas.

Apart from the fact that so much of the gas available would be produced at a low cost, the advantages of using gas instead of coal, providing that it can be burnt economically for the purpose of generating steam, are self-evident. As the matter stands at present, a large amount of space has to be devoted to the storing of coal at very large power stations. The machinery for handling it represents a considerable capital sum, and also makes a fair demand upon the power available for its working. Large buildings of some kind are necessary for the storage of the coal, and an elaborate system of hoisting, weighing, and conveying apparatus is required to transport it from the trucks or barges, in which it arrives at the works, to the mechanical stokers; while a further system of conveyors, and sometimes of hoisting apparatus, is required to deal with the ashes from the boiler furnace. The latest and best method of delivering the coal to the boiler furnaces is by means of mechanical stokers. Although they represent a great improvement in boiler practice, and give rise to substantial economies in the cost of raising steam, they require a considerable capital outlay, and a considerable amount annually in repairs and attendance. Compare this with gas brought to the boiler by one or more pipes, and burnt in a special chamber designed for the purpose, and in burners also specially designed for boiler work. We can perhaps get a rough idea of the difference in working boilers by gas, providing it is economical in other ways, by referring to the problem—it is a very similar one—that we have to deal with in our own homes. Many of us have experience of chest trouble, bronchitis, etc., and, as we know, the first requirement of the doctor in attendance has been that the room shall be kept at a certain temperature, usually from 55 to 60 deg.,

day and night. As we may have found, to our cost, with coal fires it is very difficult to accomplish this. Coal has to be brought to the bedroom in sufficient quantities to keep the fire going right through the 24 hours, and someone skilled in the matter of looking after a fire has to be more or less constantly attending to it. Even with a good supply of coal, and with a very careful attendant, it is sometimes difficult to prevent the temperature of the room falling when there is a sudden fall of the temperature outside. With gas fires there is no difficulty whatever. The gas can be turned up or down, or, with the latest forms, part of the burners turned out, or relighted, as occasion requires. The patient himself, if he is not very bad, can turn it up or down, on or off. Probably many who have suffered from chest troubles during the present winter have owed their recovery very largely to the use of gas for heating their bedrooms, where they have been fortunate enough to have it.

The problem of the steam boiler is very similar to that of the bedroom where there is a patient with chest trouble. The sudden fall of temperature of the outside atmosphere, requiring an increase of gas consumption in the bedroom, would correspond with the sudden increase of load upon the engines or turbines taking steam from a boiler, or a battery of boilers. Great skill, great ingenuity, and a great amount of time and money have been expended to ensure that engines and turbines shall be accurately governed, and shall respond promptly to changes of load, cutting off the steam that is no longer required when the load falls, and promptly admitting the additional steam required when the load increases. Up to the present practically no attempt has been made to carry this back to the boiler. When changes of load are likely to be permanent for a fairly considerable time, a good stoker will arrange his fires to meet the new requirements, and a careful attendant will alter the feed of the mechanical stoker when it is employed. In neither case is there any possible chance of meeting the constantly varying demands of the engines and turbines for steam by varying the quantity of steam generated and the quantity of fuel consumed.

If the economies of the future that we are all hoping for are to be properly carried out, changes of load and changes in the quantity of steam demanded from the boilers must be met by changes in the quantity of steam produced and in the quantities of fuel and water handled. Of course, this will not apply to very small changes for very short periods, but the more nearly the steam can follow the load, the greater should be the economy of the power production.

A little consideration will show that, whilst this is not possible with coal-fired boilers, it should be quite practicable with gas-fired, providing the arrangements for burning the gas are properly carried out. The idea of burning gas in a furnace that has been designed for coal firing is very absurd; the whole arrangement is very much against the success and the economy of gas firing. The mass of the grates and their accessories absorb a portion of the heat that should go towards heating the water. The whole arrangement renders the burning of gas economically very difficult. There is no difference in this respect between the arrangement of the Lancashire and the water-tube boiler; both are equally bad for burning gas.

The boiler for burning gas should be specially designed. It should have its own furnace, where the gas would be consumed and where the rate of its consumption and the quantity of air allowed to mix with it would be under control. Probably an arrangement somewhat similar, but on a very much larger scale to that ruling with modern gas fires, would answer the purpose. Several burners specially designed to burn the gas the boiler is working with, and with special arrangements for varying the quantity of gas consumed at each burner, and the quantity of air allowed to mix with the gas at each burner, the whole of the burners being arranged together in a special chamber, the control of the gas and air being from outside. The number of burners in use would depend on the load. In men-of-war, for cruising, half, or little more than half, of the burners would be in use, unless it were preferred to use all the burners and only part of the boilers. For power stations and works generating their own power all the burners might be in use at times of peak load. Or again, part of the boilers might be laid off during time of light load, and those in use steamed to their full capacity. The point the writer wishes to make is, with an arrangement of this kind the engineer would have a far more complete control of his boilers, of the generation of steam, and the consumption of fuel than he could possibly have with coal firing, in addition to doing away with all the trouble of handling coal and ashes. If it were convenient to use all the burners attached to some of the boilers he could do so, because it should be practicable to bring any one of the idle boilers under steam in a comparatively short time. If he preferred to keep all his boilers under steam, with only part of the burners in use, he could do so. The latter arrangement would be that which would rule where there were large changes of load at uncertain times. In those cases when the load came on the additional burners could be brought into service, or in those cases where the heavy load came on very suddenly, as say, in a rolling mill, all the burners could be in use, turned down when the load was light, and ready to be turned up instantly when the load came on.

Controlling the Calorific Value.

In previous articles it has been pointed out that with coal firing the engineer has very little control of the number of heat units that are being delivered to the boiler furnace, and it was suggested that constant tests of the calorific value of the coal in the bunkers and in the hoppers of the mechanical stokers should be made, in order that the engineer might have warning of any change in the calorific value of the coal. It was pointed out that even with the most careful tests, most frequently repeated, the engineer is more or less helpless if some coal comes through that is of a lower calorific value. If, say, some coal taken from a portion of the seam that has a certain admixture of dirt comes along, he is absolutely helpless. The fires will go down for a certain time until the bad fuel has been worked off, and he can do nothing to improve matters except perhaps putting on more boiler power. With care in buying coal, and in sampling it when the first tests are made on purchase, accidents of that kind should be reduced to a

minimum. But where large quantities of coal are bought, and even where large quantities are brought from any particular colliery, it is sometimes impossible to ensure that something of the kind shall not happen. Nature has been erratic in the way she has laid the coal seams, and it is always possible that some of the coal that comes out mixed with very good coal may be of the kind mentioned above.

What the writer wants to lead up to is, that with all kinds of gas, however produced, it should be possible by proper management for the engineer to know the exact calorific value of the gas he is dealing with. It should be perfectly practicable to attach an apparatus to the pipe delivering the gas, that would show its calorific value at any moment. It should also be possible to attach the usual recording sheet to it, so that the engineer would know the calorific value of the gas delivered to each boiler right through the 24 hours. It should not be beyond the skill of our chemists and physicists to design an apparatus of that kind. Gas is constantly being tested for calorific value at gas works, and some modification of the apparatus used there should be available for use in the boiler house. Probably, completely new ground will be broken by experimenters, if, and when, the necessity arises. Electricity has shown itself able to deal with almost every case that arises, as soon as a real case is made out, and there are other sources open, such as catalysis. It will be remembered that catalysis has already been used in conjunction with electricity for determining the percentage of the gases present in the atmosphere of coal mines. Probably an extension of the principle on which the inventors of the electrical gas detectors work, would lead to the necessary requirements for testing the calorific value of a combustible gas.

It goes without saying that, providing that the other part of the boiler can be suitably arranged to utilise the heat liberated by the burning gas, such an arrangement as that outlined above would be far superior to any system of coal firing.

In the writer's view, the control of the gas employed for firing would not eventually be left to the boiler attendant. Supposing a boiler or a battery of boilers to be fired by gas on the lines described above, each boiler furnace having a number of burners, and each burner being arranged to control the quantity of gas it was burning, and the quantity of air mixed with the gas, and each supply pipe fitted with apparatus showing the calorific value of the gas at each moment, the condition of the load also being repeated in the boiler house; the boiler attendant could regulate the number of burners in use in each boiler furnace, and the quantity of gas each burner was consuming, and the quantity of air allowed to mix with the gas by hand.

If the boilers were attached to an electric power station, it would be a simple matter to arrange electrical instruments in the boiler house, duplicates of those on the switchboard, that would show the boiler attendant the state of the load at any instant; and usually he and his assistants would have time to alter their burners when the heavy load was coming on and when it was going off. The writer suggests, however, that invention will go beyond this, and that automatic apparatus, probably worked by electric currents, will vary the gas and the air in each boiler furnace with temporary changes of load that are sufficiently great to mean something in the matter of economy. When gas firing on the lines indicated above has thoroughly established itself, it will be a comparatively small step to control it automatically in accordance with the requirements of the load.

(*To be continued.*)

MODERN STEAM TURBINES.

By J. Humphrey.

(*Continued from page 295.*)

The controlling governor fitted to the Brown-Boveri turbine was described by the writer in *The Industrial Engineer* of November 8th, 1917, and it is therefore unnecessary to describe it here. It will suffice to say that a great deal of ingenuity has been brought to bear upon the design of this governor, and in order to obtain very close governing the inlet valve is kept in a state of constant tremor. It will perhaps be remembered tha the governor is actuated by oil under pressure, and not by steam, as in the case of the Parsons' blast governor. The advantage of using oil under pressure is, as pointed out in a previous article, that in the event of the oil supply failing and the main bearings so being deprived of oil the turbine shuts down automatically. The governor gear is to be seen at the right-hand end of the large turbine shown in Fig. 92, the automatic nozzle valves being situated on the top of the casing. This turbine is a much larger machine than any of the turbines so far illustrated, it being rated at 15,000 kw. It was built in the works of Messrs. Richardsons, Westgarth, and Co. Ltd., and erected in the Stuart Street station of the Manchester electricity works. The machine is built on the combined impulse and reaction principle, and runs at a speed of 1,500 revolutions per minute. It is coupled to an alternator built by the British Westinghouse Co. The impulse wheel of these turbines is only omitted when the quantity of steam available is sufficient to justify the use of reaction blades in the high-pressure section, as, for example, in the case of back pressure and exhaust steam turbines. Short reaction blades have an unfavourable influence on the efficiency, not so much on account of the clearance losses as on account of the disturbing influence of the walls and ends of the blades on the outer surfaces of the annular current of steam passing through the turbine. The longer the blades the smaller is the proportion of the disturbed to the undisturbed steam zones of the annular currents of steam. Hence the smaller the volume of steam flowing through the turbine in a given time, the smaller must be the diameter of the drum. The peripheral velocity of the blading for a given speed and quantity of heat energy dealt with in a single-pressure stage are therefore reduced, and consequently if it is desired to use the steam to the best advantage a greater number of stages will be required. But when the number of stages necessary to secure this result exceeds a certain limit the extra cost of construction becomes disproportionate to the gain in economy, and it is for this reason that the

Brown-Boveri turbine is fitted with a velocity wheel at the high-pressure end. Some makers of steam turbines, however, prefer always to adhere to reaction blading throughout, but, as pointed out in a previous article, the high-pressure section of a pure reaction turbine takes up a length out of proportion to the total length of the machine, particularly in the case of small turbines working with high-pressure steam. In any case it will be understood that the Parsons' blading is a characteristic feature of the Brown-Boveri turbine, since even with the impulse wheel the greater portion of the output is developed by the reaction section.

In addition to the ordinary high-pressure turbines as used in power stations, various modifications are also made, such as exhaust steam and mixed pressure consist of two separate cylinders—a high-pressure cylinder with the steam admitted at one end, and a low-pressure cylinder having the steam admitted in the centre, an arrangement specially suited for dealing with large volumes of low-pressure steam, and at the same time obviating the necessity for the provision of dummy pistons to balance the end thrust. Turbines with steam entering at the centre are called double-flow turbines. The Brown-Boveri mixed pressure turbine also has the low-pressure steam admitted in the centre, but in addition a velocity wheel is attached to the right-hand end of the rotor, through which the higher pressure steam passes, this steam first being expanded in nozzles in front of the velocity wheel in the ordinary manner. When there is a plentiful supply of low-pressure

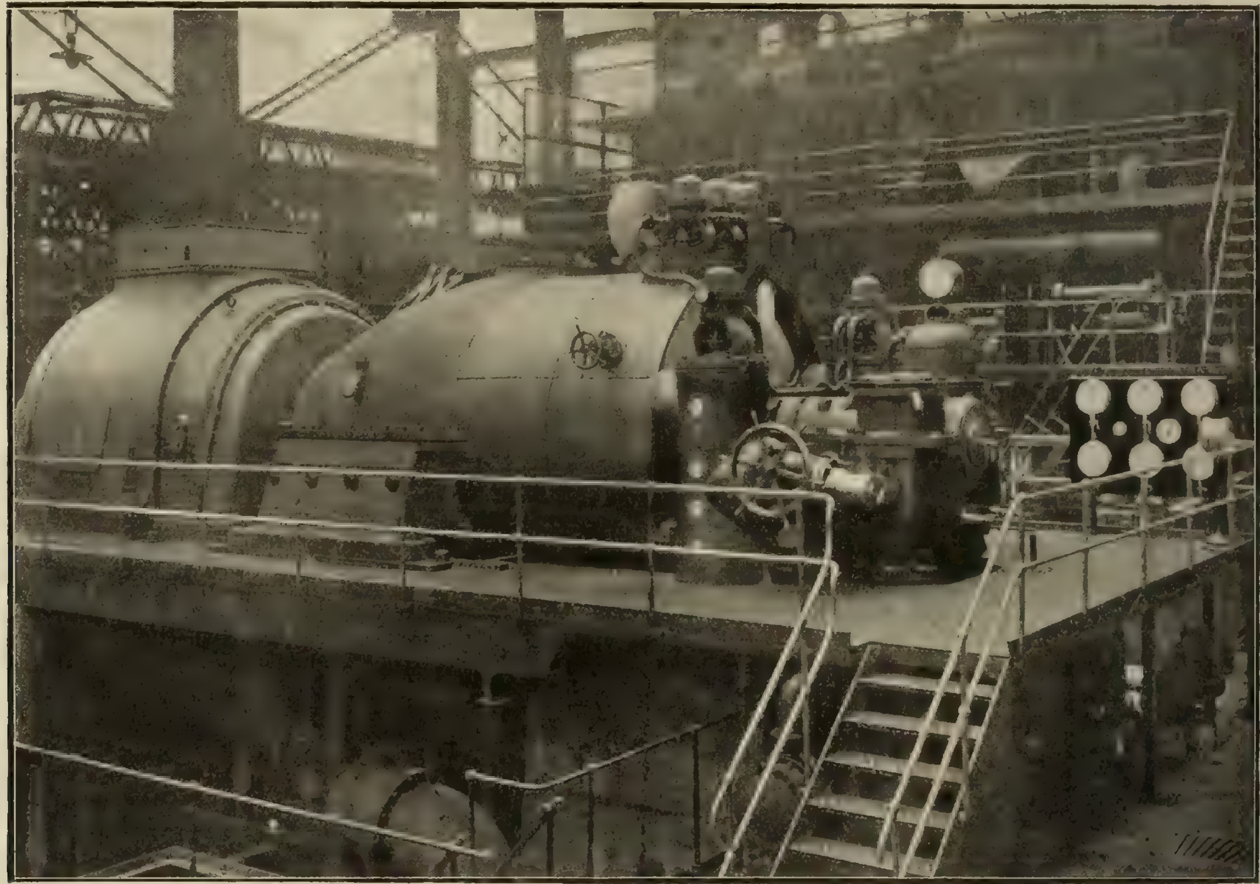


Fig. 92.—A 15,000 Kilowatt Brown-Boveri Turbine built for the Manchester Corporation Electricity Works

turbines. The Brown-Boveri exhaust steam turbine is similar to the standard condensing turbine with the exception that at the high-pressure end the nozzles and impulse wheel are omitted so that the turbine becomes a pure reaction machine. For dealing with large quantities of steam such turbines are made so that the steam enters in the centre and flows through the blades in opposite directions, and finally into the exhaust. This is an arrangement which has not previously been referred to in this series of articles, although it has been adopted in the past for turbines working at high pressures, and some of the largest steam turbines working in America are built in this manner. In many cases, however, these turbines

steam, no high-pressure steam is, of course, admitted to the nozzles, the whole of the power being developed by the low-pressure steam entering at the centre of the turbine casing. But when the amount of exhaust steam available is insufficient to cope with the load high-pressure steam is admitted to the impulse wheel through the nozzles. An automatic valve controlling the high-pressure steam supply opens when the pressure of the exhaust steam falls to a predetermined value. Of course, when no exhaust steam is available the whole of the power is developed by the high-pressure steam entering through the nozzles. The Brown-Boveri back pressure turbine differs from a standard turbine, working

condensing in that the exhaust pipe is not coupled up to a condenser, the exhaust steam being, of course, used for heating or some other purpose. As a rule, these turbines are not fitted with an impulse wheel, and in order to deal with the larger quantities of steam resulting from the absence of the condenser, the high-pressure blades are made long and are liberally dimensioned so that reaction blading can be advantageously employed throughout. Another type of Brown-Boveri turbine is the by-pass turbine, intended to be used instead of a back pressure turbine when the required quantity of heating steam is small in comparison with the steam needed to make the turbine develop the requisite amount of power. In this case the turbine works condensing in the ordinary manner, but at a point behind the impulse wheel a steam tapping is taken off, and from this tapping the supply of low-pressure steam is drawn. In order to keep the pressure of this steam constant, in spite of changes in the load or variations in the demand for heating steam, an automatic by-pass valve is provided, the operation of which being somewhat similar to that of an ordinary safety valve. The valve is attached to a piston, one side of which being subjected to a constant pressure obtained with the help of a reducing valve, whilst the other side is acted upon by the steam pressure in the heating main. Hence, as soon as the latter pressure rises the valve lifts and allows a larger quantity of steam to pass into the high-pressure part of the turbine.

(To be continued.)

THE INDUSTRIAL LEAGUE.

The industrial discontent which has come so notably to a head of late and which was certainly displaying itself prior to the war has brought together various bodies of thoughtful citizens with a view to finding some means of steadying the industrial car if they cannot discover a way of making it run with perfect smoothness. The Industrial League, of which the Rt. Hon. George H. Roberts, M.P. is president, is one of these bodies, and it has been working for the last four or five years in a very unostentatious manner with the object of improving the relationship that exists between employers and workers. How far it has been successful in its mission it is impossible to say, but few people who think sanely will be found to disagree with its objects.

On the occasion of a recent dinner given to the technical press by the Chairman and Executive of the League, we had an opportunity of learning from Mr. Roberts not only what were the tenets of the League, but what his own views were with regard to the all-important question of production, not only for home consumption, but also for export. Mr. Roberts is one of the more shrewd of our labour leaders, and he is not lacking in candour towards a certain section of his own party. Indeed, he strongly resents the actions of that element which would utterly bring discredit upon the labour movement, if it has not already done so. He reminds them that both they and capital are in the same boat; that in order to get to the desired economic haven they must—with capital—exert themselves to the utmost during those hours which it is possible to do so. In other words, he tells labour that in order to safeguard its own future it must insist throughout its own ranks on a proper output of work. The heavy debt which lies on this country as a consequence of the war must be paid for by the unstinted work of all.

So far as the functions of the Industrial League are concerned, these are exclusively propagandist and advisory. Mr. Roberts points out that "they have sought to disseminate knowledge, to diffuse goodwill, and generally to create an atmosphere favourable to a dispassionate consideration of the relations of employers and employed." He expresses the hope that the real and the ideal shall concave together in the minds of our people, whereby we shall help to bring forth plainer truth, greater order and sweeter harmony.

The Industrial League is the outcome of a series of small meetings of employers and labour leaders, held for the purpose of frank discussion and mutual enlightenment. It was the marked success of these meetings which encouraged the members to extend the field of the League's activity. What it does not do is to interfere between the employers and labour organisations, nor take part in any trade dispute. The Committee feel, therefore, that members will be able to discuss industrial questions of mutual interest with greater freedom and sincerity than would be possible if they felt they were committing their respective organisations.

The League supports the formation of Industrial Councils or Works Committees having the same objects as itself. It also supports generally the movement for shorter hours, minimum wages, better housing, and improved workshop conditions. It also draws attention to the necessity of supporting small employers engaged on special manufacturing, and would seek to encourage the workers to develop ideas for improving processes and machinery.

Amongst the employing firms who are represented on the Executive Committee are Whitmore and Bailey Ltd., the General Electric Co. Ltd., British Aluminium Co. Ltd., Petters Ltd., and the British Empire Producers' Organisation. Amongst the labour leaders on the Committee are Mr. A. Bellamy, National Union of Railwaymen; D. Gilmour, Scottish Miners' Federation; J. Seddon, M.P., and Robert Young, M.P., Amalgamated Society of Engineers. The Organising Secretary is Mr. John Ames, 66, Victoria Street, London, S.W.

DIESEL ENGINE USERS' ASSOCIATION.

MAY MEETING.

At the last meeting of the Diesel Engine Users' Association the subject of "Insurance of Diesel and semi-Diesel Engines against Breakdown" occupied the attention of the members. Some time back the Association, after careful consideration, had adopted a standard form of policy of insurance against breakdown. One of the conditions adopted provides that in the event of disagreement of the interpretation of the policy, the matter shall be submitted for arbitration between the assured and the underwriters to a special committee of the Diesel Engine Users' Association, whose decision is to be final and binding on both parties. A case in which a dispute had arisen was reported to the meeting, and a special committee to deal with this matter was appointed.

The Association proposes to take action in regard to carrying out research work with a view to obtaining more definite information as to the suitability of various classes of liquid fuels for use in Diesel and semi-Diesel engines, or for other purposes, and it was decided to make application for a Government grant in aid of this work.

A discussion took place on the report made at the previous meeting by Mr. G. W. F. Horner on the breakdown which had occured on a Diesel engine at Weymouth. Apparently the trouble had been caused by the fracture of a connecting rod big-end bolt. In this connection various opinions were expressed on the subject of fixing a useful life for such bolts before renewal, and the opinion of various speakers as to a proper limit to allow for the useful life of such bolts varied between 5,000 and 20,000 working hours. The question of the efficiency of heat treatment or annealing of bolts of various classes of steel was also discussed, and in connection with heat treatment the Wild-Barfield type of automatic electric furnace was mentioned and briefly described. A desire was expressed by several speakers for the collection of more definite information as to the practice adopted by various makers and engine users in connection with he renewal of connecting rod bolts or of the adoption of any system of annealing or heat treatment, and if so, what period of working hours was allowed before annealing, and whether such annealing or heat treatment could be satisfactorily repeated several times. It was understood that the Honorary Secretary would endeavour to obtain such information from various sources with a view to the ultimate adoption of some general rule or recommendation by the Association. Engine manufacturers, engine users or companies interested in insurance of engines against breakdown, who may be interested in this matter, are invited to communicate with Mr. Percy Still, honorary secretary of the Association, at 19, Cadogan Gardens, S.W. 3.

THE ATOMIC FORCES OF EXPANSION AND CONTRACTION.

By Edward Ingham, A.M.I.Mech.E.

One of the first things taught to a student of science is that bodies in general expand on being heated and contract on being cooled. To the engineer, this simple fact is one which must ever be borne in mind. In the laying of railway lines, the erection of steam piping, the design of a steam boiler, etc., it must not only be remembered that expansive movements will take place, but also that provision must be made to accommodate these movements. Failure to observe this may result in disaster.

The forces of expansion and contraction act silently and unseen, but with terrible effect. These forces are practically irresistible, and the engineer who fails to make provision for them will soon find this out to his cost.

No better illustration of the enormous stresses which may be set up by expansive forces can be given than a brief description of an experiment which we believe was first proposed by Professor Tyndall. A sphere of cast iron some 2 in. or 3 in. in diameter and about ½ in. thick is filled with water, hermetically sealed, and then placed in a freezing mixture. The water commences to cool down and eventually freezes, when the vessel is burst (with a loud report) into two pieces. It will be remembered that although water contracts on being cooled down to a temperature of 4 deg. Cen., it begins to expand on further cooling—*i.e.*, on freezing, and although the sphere is of enormous strength, it is quite unable to resist the tremendous forces set up during the expansion. The pressure actually needed to burst a small sphere such as the one in question would probably be many thousands of pounds per square inch. Any attempt therefore to resist the forces of expansion or contraction will prove fruitless.

After what has been said one cannot wonder that the internal linings and the outer casings of gas and oil engine cylinders frequently fracture in frosty weather when the water is left standing in the jackets. The precaution of leaving a small light burning under the jacket, or of emptying the jackets of water, is obviously not an idle one. We have in mind the case of a steam boiler which was left filled with water during a spell of frosty weather. The water eventually froze into a solid mass, and the expansion set up during the freezing burst the shell throughout the whole of its length.

Fractures in steam boilers have sometimes been set up as a result of playing over the hot plates, immediately after emptying, with cold water from a hose pipe. It may be shown by a simple calculation that the stresses brought into play in this way may be quite sufficient to rupture the best mild steel plates.

The amount of expansion (or contraction) which takes place when any particular metal is heated (or cooled) through any given range of temperature may be easily calculated. Thus,

If t_1 be the intial temperature of the body,
t_2 be the final temperature of the body,
L the length of the body in inches,
a the coefficient of expansion of the metal,
E the amount of expansion,
then $E = L\,(t_2 - t_1)\,a$.

The coefficient of expansion for the different metals may be obtained from any engineering pocket book. For iron or steel the coefficient is approximately .0000067. If we apply this simple formula to determine the amount of expansion which will take place in a range of steam pipes when steam is turned into the pipes, we shall find that the amount of expansion is between 2 in. and 3 in. per 100 ft. of length, the actual figure depending, of course, upon the temperature of the cold pipes and that of the steam. For general purposes it is useful to remember that for every 100 ft. of length an expansion of approximately 2½ in. will take place, and suitable provision, in the form of gland expansion joints, spring bends, and expansion diaphragms, etc., must be provided. If, of course, the steam be superheated, the expansion will be considerably more than this, depending on the amount of superheat.

In the case of a steam boiler of the Lancashire type, the furnace and flue tubes expand more than the shell under working conditions, and this imposes

a more or less severe strain on the end plates. It is most important that the latter be made to some extent flexible, so that they can accommodate the expansion, as otherwise serious grooving about the connections of the tubes to the plates will be set up. A certain amount of flexibility may be obtained by leaving a sufficient amount of what is called "breathing space" between the rivets in the furnace tube flanges and the bottom rivets of the gusset angle irons, and with low-pressure boilers, a space of not less than 10 in. or 11 in. will generally be sufficient to prevent grooving. In the case of modern boilers, however, the steam pressures are often so great that it is a most difficult matter to provide the necessary flexibility and at the same time obtain the required strength, and at the present time grooving in the end plates or the tube connections is one of the most common troubles. The difficulty has been overcome in some cases by making the bottom rivets of the gusset angles of a special form, so that the end plate may move out a slight amount as expansion of the tubes takes place.

At the back end of the boiler expansive movements commonly give trouble by forcing back the brickwork bearing against the end plate, and leaving a space through which cold air leaks in large volumes into the flues. This is a common cause of loss of efficiency, and at the present time great efforts are being made to provide suitable devices for preventing this loss.

A certain amount of risk of fracture is incurred with tandem steam engines as a result of expansive movements. It is not difficult to imagine that if the cylinders be securely bolted to the engine bed so that free expansion is prevented, fracture of the feet or other parts may possibly occur, and breakdowns have indeed been brought about in this way.

Sufficient has now been said to show that the atomic forces of expansion and contraction may in many cases be regarded as real enemies, but, on the other hand, there are many ways in which we may put these forces to actual advantage. For example, engine cranks are commonly secured to their shafts by the process of shrinking on, which consists of boring the crank to a diameter slightly less than that of the shaft, then heating the crank so that it expands just sufficiently to enable it to be placed on to the shaft. During the cooling which subsequently takes place the crank contracts and grips the shaft with such force that there is little liability of its moving when the engine is put to work, notwithstanding the severe conditions of working. Those who have had experience of removing shrunk cranks from their shafts will appreciate the great difficulty which is sometimes met with in accomplishing this object. Wheel tyres are shrunk on to the wheels in a similar manner, whilst segments of flywheels and the different sections of large engine beds may be securely fastened together by wrought iron or steel hoops shrunk on whilst hot and afterwards allowed to cool.

Another way in which the forces of contraction have been put to great advantage is in straightening the walls of buildings. Where the walls have become badly bulged, long bolts with large washers and nuts are made to span from wall to wall, the nuts being screwed up until tight. The bolts are then heated throughout their length, and so made to expand, when the nuts are again screwed up. As cooling takes place the bolts contract, so exerting an enormous pull on the walls, and in this way the latter may with care be brought back to their original position.

Other instances might be referred to, but those mentioned will serve to show that these all-important forces of expansion and contraction, although they may prove so troublesome to designers of machinery, are nevertheless not without their useful applications.

THE MEXICAN PETROLEUM INDUSTRY.

The Mexican petroleum beds, the wealth of which has not yet been completely estimated, extend over a superficial area of 4,600 square kilometres on the coasts of the Gulf of Mexico, on the Pacific watershed up to Tehuantepec, and also on the terrain of lower California. These beds yield the three principal varieties of petroleum known by the names of Pennsylvania, Baku, and Galicia because of their similarity in quality to the oils of those origins. Mexico also produces petroleum not only with an asphalt but also those with a paraffin basis; the first is the most abundant, and it is characterised by a blackish-green colour, a heavy oleaginous consistency, and a density varying from 0.875 to 0.970 at 15 deg. Cen. It is very rich in asphalt, contains from 3 to 5 per cent sulphur, and its heating power is about 10,000 calories. It bursts into flame or "flashes," according to density, between 0 deg. and 15 deg. Cen., and ignition takes place between 50 deg. and 250 deg. Cen. Upon distillation this petroleum yields naphthas, intermediate oils, and naphtha products.

In the working of the petroleum-bearing beds, the yield obtained is in excess of transport facilities, and also of the requirements of those markets hitherto supplied by oils of this origin. Although exportation is increasing daily, it still does not amount to one-fifth of the potential output of the Mexican wells, which is estimated to be one million barrels per day. This yield does not seem at all likely to decrease; since December, 1910, certain wells have been yielding 100,000—35,000 and 15,000 barrels per diem without the slightest variation at all in the pressure or temperature of the jets ever since the day when the boring was first made. In the Zuypam region wells yielding from 30,000 to 60,000 barrels daily are of common occurrence. At Cerro Azul there is even a well giving the enormous daily yield of 261,000 barrels, or about 41,500,000 litres of raw petroleum. Exportation, as stated, is increasing rapidly; in 1916 there were exported 40 million tons of combustible and raw oil, and in 1917 the total increased to 80 million tons in spite of the difficulty in obtaining means of transport.

On Mexican railways the use of petroleum as a fuel has now become general, and represents nearly the whole of the home consumption; in fact, the consumption by the railways amounts to 345 thousand barrels monthly, or about 621,000 tons yearly.

The actual value of the petroleum bearing lands depends upon the situation of the wells, in relation to the means of transport; thus land situated close to rivers is worth from 1,000 dollars to 4,000 dollars

per hectare, whilst if distant from navigable rivers the hectare can be got for from 100 dollars to 250 dollars. On the banks of the River Panuco the few petroleum lands still available may be purchased at from 1,000 dollars to 5,000 dollars per hectare; in 1895 the self-same land was going at 20 cents per hectare! The oil obtained from this region is sold, according to Government standard fixed for five years, at from 10 to 12 American cents gold per barrel delivered at mouth of well, or at 15 cents delivered on barge. These prices are for low grade fuel oils of about 12 deg. Bé., oils of from 14 to 15 degs. Bé. costing from 3 to 4 cents more per barrel. The oil is sent down to Tampico, Lobos or Tuxpam on barges towed by steam tugs; for this purpose there would be a good opening for steel, or armoured concrete, tank steamers, and the United States are beginning to use them with great success. They use petroleum as fuel, are economical in use, and take the petroleum from Mexico to various American and South American ports.

ELECTRICAL DEVELOPMENT IN CATALONIA.

As *The Electrical Review* points out, Catalonia is the Lancashire of Spain, and its capital, Barcelona, has the characteristics of Liverpool, Manchester, and Birmingham combined. The prevailing lack of coal has not been acutely felt in Catalonia owing to the fact that the province is very rich in water-power, and some very large hydro-electric plants have now been in operation for some years. The following table gives some idea of the existing installations and the possible development:—

Water Power in Catalonia.

Owned by—	H.P. installed.	H.P. in construction.	H.P. in reserve.	Total H.P.
Riegos y Fuerzas del Ebrao	96,500	60,000	185,000	341,500
Energia Electrica de Cataluna	42,000	20,000	145,000	207,000
Cataluna de Gas y Electricidad	12,000	24,000	200,000	236,000
Sociedad Productora de Fuerzas Motrices	—	24,000	40,000	64,000
Other ownerships	—	—	256,460	256,460
Totals	150,500	128,000	826,460	1,104,960

Thus 13.5 per cent of the total power available is already installed, and 11.5 per cent is still under construction, leaving 75 per cent not yet touched.

On the 20th inst. the T.S.S. Port Bowen left the North Yard of Messrs. Workman, Clark and Co. Ltd., Belfast, and proceeded down the Lough to adjust compasses and carry out official trials. The dimensions of this twin-screw steamer, built to the order of the Commonwealth and Dominion Line, are 480.7 ft. by 62.48 ft. by 41.49 ft., with a gross tonnage of 8,267.23. The cargo gear is of the latest type, and the large number of winches and derricks are specially arranged for the expeditious handling of cargoes. The machinery, which was also built by Messrs. Workman, Clark and Co., consists of two sets of Brown-Curtis double-reduction turbines, with ample boiler power. The speed of the vessel is 14 knots.

Trade Items, Notes, &c.

British Machine Chain Ltd. (156,081).—Private company. Registered June 14th. Capital £15,000, £1 shares. Agreement with Ceda St. Pierre, Jean I. Tero, and A. F. Tero. As title. Directors: A. F. Tero, C. St. Pierre, J. A. Robinson and F. V. Robinson. Office: 95-7, Finsbury Pavement, E.C.

Imperial Institute of Patentees.—A new association is being formed by patent owners and manufacturers with the object of protecting their interests; the association will probably be known as the Imperial Institute of Patentees (Inc.), licence from the Board of Trade having been applied for. A preliminary meeting will take place in the Pillar Hall, Cannon Street Hotel, on Thursday, the 10th July, at 2-30 p.m. Mr. Godfrey Cheesman, the General Secretary of the National Union of Manufacturers (Inc.), has been asked to act as organising secretary to the new Association. Temporary offices have been secured at 6, Holborn Viaduct, London, E.C.4, and all interested in patents and desiring to attend the meeting should apply for tickets and other information. The chair will be occupied by Sir Joseph Lawrence, Bart., of Messrs. Linotype and Machinery Ltd., who will be supported by Sir Herbert Nield, K.C., M.P., Mr. George Terrell, M.P. (Messrs. Tyer and Co. Ltd.), Sir Richard Cooper, Bart., M.P. (Messrs. William Cooper and Nephews), Mr. C. H. Skinner (Messrs. Lilley and Skinner Ltd.), Mr. Percy G. Donald (Messrs. Rownson, Drew, and Clydesdale, Ltd.), and others.

Mining Electrical Engineers.—A meeting of the Midland branch of the Association of Mining Electrical Engineers was held at the University College, Nottingham, on Saturday. The election of officers by ballot resulted as follows:—President, Mr. W. Wynes, Clipstone; vice-presidents, Mr. F. Church, Tibshelf, and Mr. A. R. Davies, Bolsover; secretary and treasurer, Mr. E. R. Hudson, Ilkeston; council, Messrs. E. Cusworth, East Kirkby; H. Dean, Forest Town; E. E. Beadsmore, Pinxton; A. Lees, Rainworth; C. E. Tissington, Staveley; and B. Buckland, Bolsover; auditors, Mr. F. Smith, Pinxton, and Mr. F. W. Rowley, Eastwood; sub-editor of Transactions, Mr. Beadsmore. A resolution was unanimusly passed to form a committee to inaugurate a Colliery Electricians' Society for the Midland district.

The Industrial Tour of Brazilian Delegates.—On Monday, June 23rd, the Brazilian Commercial Delegates who are on a visit to this country began, in company with a representative delegation from the Federation of British Industries, the business side of their programme. On that day the refrigerating machinery works of Messrs. J. and E. Hall were visited; Tuesday and Wednesday were devoted to visits to explosives works and docks in London; Thursday they went to the electric lamp works of the General Electric Co. Ltd. On Friday, the 27th, there was a Federation lunch at the Savoy, and in the evening a Government dinner at the Carlton Hotel. On Saturday, June 28th, a trip was made by road to Windsor, followed by a journey on Sunday to Birmingham, which was their centre for five days, during which the Wolseley Motor Works, and Millward's needle works at Redditch, Willans and Robinson's works at Rugby, Kynoch's, and Alldays and Onion's works at Birmingham was visited. On Friday, July 4th, the party proceeded to Glasgow, where they visited David Colville's, Beardmore's and Nobel's works. On July 12th they will proceed to Edinburgh and see the North British rubber factories. On Tuesday, July 15th, they will be at Armstrong, Whitworth's at Newcastle; on the following day at the Parsons' marine turbine and North-Eastern Engineering works. Darlington receives them next at various works. The delegates will reach Liverpool in time to visit the British Insulated and Helsby Cable works on July 21st. While at Manchester they will see the Armstrong, Whitworth, British Westinghouse, Crossley Motor, and other works, also the Manchester Ship Canal. On July 28th one section of the party will proceed to Sheffield, and the other to Bradford. Hadfield's, Firth's, and many other factories are in the programme. Leicester next receives attention, and thereafter movements are dependent upon the Government decisions in regard to Peace celebrations. After these celebrations the tour will be resumed on August 10th, and Bristol and Swansea will exhaust the intentions, if not the energies, of the party. The official programme is, as in the case of a previous tour, carried through by the F.B.I., prepared in excellent style, and we have no doubt that the efforts of the Federation will bring in due course ample repayment in the shape of Brazilian business as the result of the very effective demonstration that will be given of British industrial capacity.

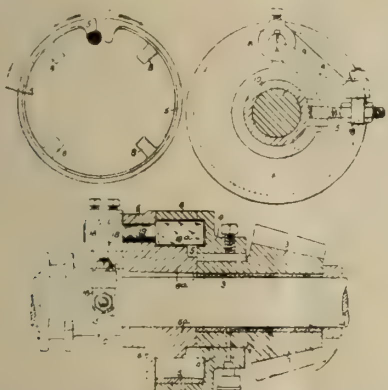
Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

he following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

LUTCHES.

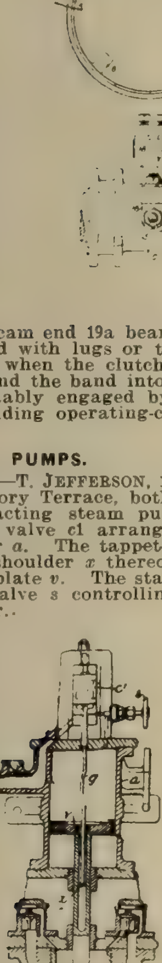
120,054.—A. RAY, 11, Leigh Street, and W. BOULTON LTD., Navigaon Road, both in Burslem, Stoke-on-Trent.—July 23rd, 1917.—In and friction clutches, a drum 4 is secured to a driven bevelheel etc., 3 is closed by a cover 6 which turns a stud 19



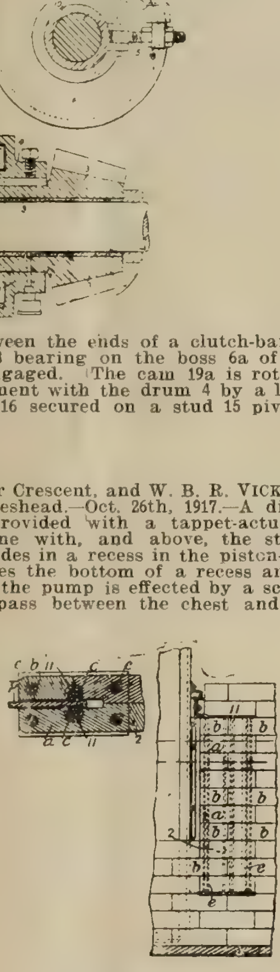
ith a cam end 19a bearing between the ends of a clutch-band 5 rovided with lugs or the like 8 bearing on the boss 6a of the over 6 when the clutch is disengaged. The cam 19a is rotated expand the band into engagement with the drum 4 by a lever rotatably engaged by a pin 16 secured on a stud 15 pivoted a sliding operating-collar 10.

TEAM PUMPS.

120,091.—T. JEFFERSON, 16, Poplar Crescent, and W. B. R. VICKERS, Rectory Terrace, both in Gateshead.—Oct. 26th, 1917.—A direct ouble-acting steam pump is provided with a tappet-actuated -slide valve c1 arranged in line with, and above, the steam ylinder *a*. The tappet-rod *g* slides in a recess in the piston-rod, nd a shoulder *x* thereon engages the bottom of a recess and a appet plate *v*. The starting of the pump is effected by a screwown valve *s* controlling a by-pass between the chest and the ylinder.



Patent 120,091



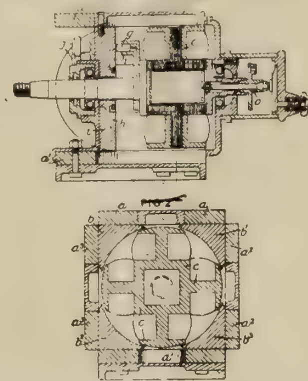
Patent 120,143

TEAM GENERATORS.

120,143.—M. J. HILL, Bury Bridge, and J. W. HILL, 108, Bolton treet, both in Bury, Lancashire.—(Legal representatives of J. ill.)—Dec. 27th, 1917.—Relates to a sliding gas-tight joint between he end of a Lancashire, etc., boiler and the walls of the downake, of the kind dscribed in Specification 6,301/14. The channels in he brick walls 2 receiving the roller or guides 11, between hich slide the plates *p* projecting from the end of the boiler, re formed by the alignment of recesses at the middle of long ricks *a* and at the joint of short bricks *b*. The recesses are f greater cross-section than the rollers or guides, and are filled n with fire-clay, mortar, and the like *c*. The walls are trengthened by rods or bars *e* passing through vertical holes n the bricks, the rods or bars being surrounded by fire-clay, nortar, or the like.

IAGNETO-ELECTRIC MACHINES.

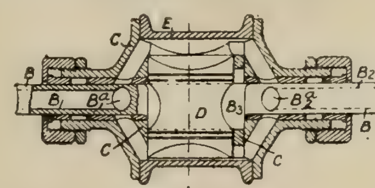
120,167.—SIR G. SMITH, 237, Cromwell Road, London.—April 0th, 1918.—A multipolar magneto comprises four or more orseshoe magnets *a*, *a*1, *a*2, *a*3 connected to pole-pieces *b*, *b*1, *b*2, *b*3 and enclosing a multipolar armature *c*. The rotating brush *g* of the distributor rubs upon contact segments *h* on a vulcanite or like end-plate *i* carrying terminals *j*. A condenser



of tinfoil and mica is placed within the armature, and an interrupter *o* of usual construction is employed.

ROTARY PUMPS.

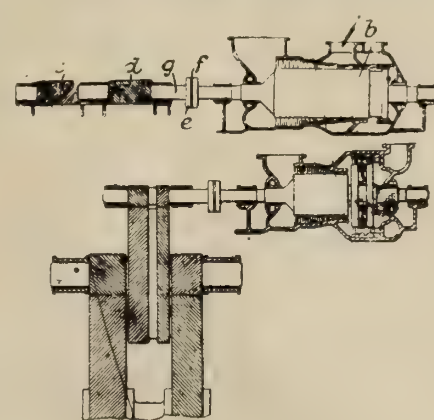
120,246.—E. L. COPSEY, Laureldene, Old Heath, Colchester.—Oct. 29th, 1917.—Relates to a rotary pump of the kind in which a cylinder C containing the pump piston is rotatably supported on a stationary shaft B having axial passages B1, B2 serving as suction and delivery conduits, with which suction and delivery ports B, Ba2 in the cylinder register periodically during the



rotation of the cylinder, the piston being reciprocated by an eccentric support; and consists in providing a single doubleended piston D, which is reciprocated directly by its eccentric support B3 without the intervention of a connecting-rod, etc., and driving the cylinder C directly from a driving belt, etc., engaging a rim E. In a modification, the piston is reciprocated by a block on a pin eccentrically mounted in the inner ends of the parts of the shaft B.

GEARED TURBINES.

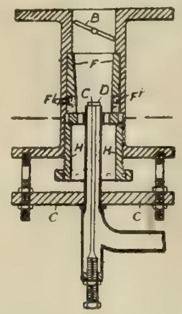
120,257.—SIR C. A. PARSONS, S. S. COOK, and L. M. DOUGLAS, Heaton Works, Newcastle-on-Tyne.—Nov. 1st, 1917.—To dispense with sliding couplings and elaborate thrust block arrangements in geared turbine systems, the turbine rotor *b* is connected directly to the pinion shaft *g* by a fixed coupling *e* having an adjustable pad piece *f*, and the intermeshing double helical teeth of the pinion *c*, *d* are arranged to determine the normal longitudinal position of the rotor. One of the helices of the double helical pinions may be formed longer than the other so as to balance



the thrust exerted by the turbine and secure uniform distribution of pressure across the pinion teeth and the most favourable distribution of forces so far as deflection due to torque of the pinions is concerned. The teeth of the two helices may be cut at different angles to secure uniform distribution of pressure on the gear teeth. Applications of the invention to several forms of balanced and unbalanced impulse and reaction turbines with or without adjusting blocks are described. Fig. 10 shows a double reduction gear having the complementary helices in both primary and secondary gears of unequal widths. Instead of unequal widths, the helices may have unequal angles.

INTERNAL-COMBUSTION ENGINES.

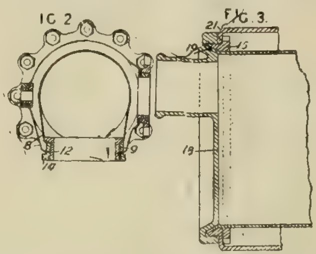
120,270.—J. S. HILL, Spath Road, Didsbury, Manchester.—Nov. 7th, 1917.—The gas issues from the end of a nozzle C controlled by a beat valve D or through lateral perforations controlled by



a piston valve. The nozzle is supported on an adjustable plate c. Air passes upwards through a choketube F, with a valve at its base. This valve may comprise a ring F1, of resilient material which can be compressed to diminish the air passage by screwing up the tube H. There is also a throttle valve E.

INTERNAL-COMBUSTION ENGINES.

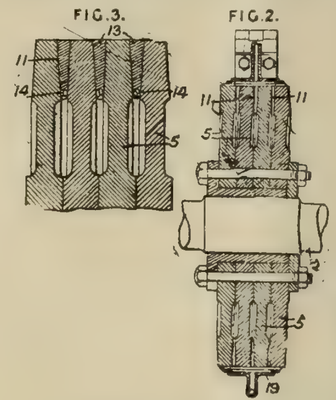
120,503.—G. GREEN, Pelham Villa, Strawberry Vale, Middlesex, and F. MAY, Thames Bank, Grove Park, Chiswick, London.—Jan. 3rd, 1918.—A sheet-metal jacket is attached to an engine exhaust pipe, by clamping its edges between screwed flanges and, to facilitate the attachment at the lateral branches of the pipe the jacket may be of **D** section, a hole being cut in the flat surface at



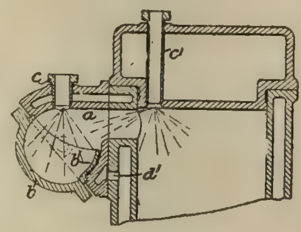
the branch which receives a screwed plug with a clamping flange. The end of the pipe is also of **D** section externally to fit the pipe. A sheet-metal pipe and its jacket may be joined at the ends by splaying them and gripping them between conical surfaces on two loose flanges. Or the ends may be joined as shown in Fig 3, one 19 being splayed. the other flanged as shown at 21, and both gripped between the end plate 18 and screwed ring 15. A lateral joint is made by blocking flanges 8, Fig. 2, on both pipes and clamping them between the three rings 9, 12, 14.

TOOTHED WHEELS.

120,325.—BRITISH THOMSON-HOUSTON CO., 83, Cannon Street, London.—Feb. 19th, 1918.—Relates to the manufacture of elastic helical gear wheels built up of discs 5, as shown in Fig. 2. To support the discs whilst the teeth are being cut, the spaces 11 between them at the peripheries are filled with readily-fusible material 13, Fig. 3, such as an alloy of bismuth, lead, and tin, which material is melted out after the teeth have been cut. The bottoms of the spaces 11 may be stopped by inserting soft wire or cord 14, the material 13 may be poured in through an annular casing 19 clamped on the wheel, and the wheel may be heated before the material is poured in.



Patent 120,325



Patent 120,335

INTERNAL-COMBUSTION ENGINES.

120,335.—R. E. MATHOT, 2, Salters Hall Court, London.—April 5th, 1918.—The vaporiser *a* is partly water-jacketed and is provided with a projection *b*1 on the cap *b* which shields part of the water jacketed surface. Tubes *c* or *c*1 traverse the water spaces and serve as receptacles for the fuel nozzles. The passages *d* 1 between the water jackets of the cylinder and vaporiser may be obstructed by changeable metal plates. The vaporiser is adapted to fit on to a sparking-plug socket in the cylinder so that the latter may be supplied with gas or carburetted air.

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EDITORIAL.

POOLING RESOURCES.

WE have had the opportunity of reading an extremely interesting letter on piecework and bonus questions written by an employer of repute recently engaged in many conferences held between employers and employees. It is our intention to quote largely from this, as, in our opinion, it is an extremely sane exposition of principles which could be adopted with advantage, and which would go a long way to maintain industrial peace if faithfully carried out:—

"The origin of piecework involves a two-fold principle, which is strongly characteristic—recognition and reward of individual merit, this principle until recently forming a standard to which both employer and employed yielded loyal service—superficially appealing to a casual observer as being an effective, right, and scientific rule for governing personal service.

Good government, however, has displaced this character in most of its modern laws affecting individualism, and always provides for a fairer distribution of the product of individual worth. In proof of this statement, I turn to the enactments of law affecting individualism, such as free education, free meals, technical education, grants to public institutions, graduation of taxes, and such like determinations, all going to prove that the extra worth of the productive power of meritorious individuals must provide a portion for those who are not so well placed.

The march of intelligence, without any legal enactment, displaced the view regarding piecework, and aims at adopting to-day a precarious and scattered idea in an attempt to shift the reward to individualism, and apply it in a more collective capacity, including in its scope that which equally badly includes the individual defect. The development of the piecework principle yields the system termed bonus.

Bonus schemes mostly rest upon a collective worth, and are supposed to apply to a number of individuals of a department or portion of a department, thus rewarding for collective effort the number of individuals whom the bonus scheme affects. The application of such bonus schemes inherently displays the original sin of its parent, and falls short of the true remedy of general benefit. A bonus scheme, to be true to its name and true to the probable intent of its originators, should apply not only to the immediate workers concerned, but also to those in the same works, however slightly connected with the actual manual or mechanical product of this works.

It will be seen that a bonus scheme in its general aspect, that affecting collective capacity, bears a resemblance to legislation which affects individual merit, and to the same extent denounces individual reward for individual merit, as it spreads over a number of workers, who naturally cannot be of equal productive capacity, a reward equal in application or proportionally equal to each in distribution.

It must be noted that a very distinct line arises between the interest of pieceworkers or bonus subjects on the one side and the interests of the employers on the other side. A rule of thumb suggests that any piecework or bonus scheme benefits both the employer and employed. This does not follow, as pieceworkers or bonus workers may raise their particular returns, while at the same time the employer may and has actually made a loss on his receiving. This view must not be dismissed by an indiscreet reflection, but must be allowed its full quota in the same socialistic aspect as is indicated

and insisted upon by legislative enactments, and accordingly must bear the same relation to the one side of the question as to the other, namely, employer and employed. We arrive, therefore, in relation of these two personalities, at the element term socialistic, that eventual solution of the interest of both parties in this question, and the element which is quite the right type, but unfortunately badly mauled in the minds of extremists, syndicalists, and also by the irrational and narrow personalities which some employers have portrayed.

On principles, hidden and apparent, I hold that any piecework or bonus scheme, although in inception apparently worthy, either or both do not remove their disability, and fall far short for promotion of benefit to all those concerned in their application.

Further, it is possible, and actually occurs that the application of a piecework or bonus scheme are a direct menace to the public good, both morally and in fact. I need not hesitate to say how abuse of both has been manifest and rampant on the employer's side, that class of bonus which merits the name of bribery and corruption, and on the employed side that insidious and unjust extortion created opportunely by the needs of the moment, and incipient official weakness due to "organisation in a hurry," including ignorance and unpractical knowledge of the subjects before them. I need not labour this aspect and phase of the subject except to suggest that any system having for its object the individual or collective reward of merit, which possesses such opportunity of debasement, should be avoided as wrong in principle and bad in application.

We hear of distinctive phrases coined for special application, such as "collective bargaining," "general welfare," etc.; now let me use an expressive term, "pool the resources," after faintly foreshadowing a future possibility in such a remedy as to pool the resources of a nation, as might be the ultimate object of legislative minds, or of a section of a nation consisting of counties, or a group of counties according to arbitrary geographical demands, I will apply "Pool the resources" to an individual workshop. The resources for beneficial division consists of the profit produced and allocated to all the producers, in itself photographing the ideal condition of redistribution for wealth-producing instruments, and must depend upon the total profit made during a suitable period, say from year to year. On such a basis the interest of employer and employed are aranged to run on parallel lines and become co-terminous, and of such a nature in allocation which would enlist the employees' effort to produce the best results in that particular workshop, cementing all efforts in union and harmony with best results for common good.

This profit-sharing does not determine wages, but should be subject to the worker being paid according to time employed and also to any skilled rate or standard rate to which the worker may be connected and in vogue; and also *pro rata* to the amount of wages received or due to any individual worker.

The amount of return of profit to be determined by the adopted and accepted standard per centum according as counsels would determine. Ordinary business demands suggest that this type of divisible profit-sharing must become effective after twelve months' employment, and would fall into ordinary wages return weekly or monthly as the case may be; thus, a worker received the following year, probably added weekly to each week's draft, that amount of profit-sharing due to him or her from the work of the prior year.

The principle in all bonus schemes should be confined to a system of profit-sharing for all and every one employed in a place of business. The application of this principle and details involved, form very minor difficulties of solution, and I think would be a comparatively easy task for a commission elected of employers and employed, when once accepted as the accepted conduct of our organisations.

This system should not be allowed to be the victim to the buffeting and wayward instincts of voluntary adhesion thereto, as a public benefactor voluntaryism is badly out at the knees, too downheel and too poor a relative, although of proud lineage, to do duty to social questions evolved by human conditions. The application of this allocation, therefore, means compulsion, and should receive the support of the State in uplifting the decisions of the organisations representing the demands of employer and employed to the realm of law. Our nation, therefore, would be organised on a basis of mutual prosperity, and such parasitic growths as antagonism between capital and labour, between employers and employed, would receive no sustaining foundation and become a war-cry illustrious of the early days of industry.

Organisation on such lines would develop possibility and power for industrial progress of the nation, and find fields of service in its application to questions of universal interest, would be in a position to help and co-operate in world-wide economic concerns, such as trade invasions, subsidy, excise, rebate, etc. A house undivided in itself will stand, and so will a nation, and in addition, if the time, attention, and organisation which have been bestowed on the quarrelsome task of solving demands of labour be bestowed on subjects of national welfare and advancement, progress immeasurable would accrue."

We have also been privileged to read some comments made on the foregoing scheme by one of the leading socialist leaders of a prominent union, which we quote in part:—

"The defects of the scheme are—

(1) That it does not give the workers a real voice in the management; (2) it does not give them an effective say in their working conditions; (3) a worker's bread and butter are still affected by the whim or caprice of foreman or employer, from whose decision there is no appeal. The workers feel that they have more to gain by consolidating their interest as workers than by entering their interests with those whose main object is to secure the largest amount of profit possible, and whose chief concern is that their establishments shall run along smoothly, unaffected by the industrial storms outside."

The spirit of antagonism which always arises when a suggested possible improvement is brought forward still persists on either side. It is a hereditary instinct, which unfortunately is dying hard.

We would warmly welcome any criticisms on the scheme as set out above, and promise to publish any letters received in full.

MUNTZ METAL.

A UNIQUE BRASS MICROSCOPICALLY EXAMINED.

Written and Illustrated by James Scott.

The brasses comprise one of the most important series of metals used for various engineering purposes; yet insufficient discrimination has been accorded to them by the average practical man. They are often spoken of as though they were all of one and the same composition; whereas they differ to a very considerable extent.

Before dealing with the subject selected for direct description, I will give a general survey of the brasses, in order that the several references hereafter made will be clearly understood. Although the details rightly belong to the domain of metallurgy, the engineer ought to have some acquaintance with the phase referred to.

The brasses are, of course, those alloys which are

Fig. 1.—One-thirtieth inch of Muntz Metal after etching with strong chromic acid, showing copper-rich material between the speckled grains, which are similar but less coppery magnified.

prepared by melting together copper and zinc. They vary remarkably in the amounts of the respective metals contained therein, and in mechanical properties, and so forth. The majority of commercial working grades range from about 73 per cent of copper and 27 per cent of zinc, to about 50 per cent of copper and 50 per cent of zinc. A great deal of their strength, ductility, wearing capacities, and their particular colours, depend on the treatment they receive after their preliminary formation, such as annealing, period allowed for cooling, and solidifying from a molten state; and style of casting, chilling, hammering; and the temperatures at which they are worked.

It will, obviously, be impossible for me to give full information on all these changes, nor will it be necessary for me to do so, since my main aim is to attend to a special brand.

The constituents of industrial brasses are divided into three fairly distinct groups, known as alpha, beta, and gamma solutions. It should be borne in mind that when an alloy is cooling and solidifying from a molten condition, it is possible for the separate metals to crystallise into minute particles among one another; or for them to combine chemically with each other and yield particles quite different from either metal; or give a mixture of both forms, the mass containing particles of each metal among particles of compound. These results are spoken of as solutions, although they are solid.

In some other alloys than brasses, it is common for what is called a eutectic to develop. Definite crystals first separate out as the metal is transformed from fluid to solid; but, finally, between them occur minute particles of each element in combination, etc., and this constitutes the eutectic, the melting point of which is much lower than that of the remaining particles. The significance of this matter is realisable for noting, when such an alloy is exposed to sufficient heat, that the pasty eutectic is the first portion to soften and exude, or else melt, so that it is possible for the alloy, under the influence of high frictional temperature, or in very hot surroundings, to become weak, and allow the rest of the particles to gradually shift, with the result that far-reaching modifications are involved. Brasses have no true eutectic, but consist entirely of mixed crystals.

An ordinary brass, whether it is stationary or working, is liable to undergo severe changes. The speck-like particles may slowly fuse together to produce shapely crystals; or the latter, already present or evolved at some stage, may split into coherent dust granules. It is on this account that so many mysterious effects (or defects) are disclosed in brasses, which may crack or fracture without any apparent cause. But, in all these circumstances the consequences are due to minute alterations of the invisible crystals, some of which, by shrinking, leave open interstices in the metal, the lengths of which are always likely to increase.

The tendency of the zinc to volatilise exercises a powerful action on the copper, and copper-rich, crystals.

Alpha solutions or crystal masses are soft and ductile, and the larger their proportion of zinc (within limits) the tougher they are. They are red or yellow according to the amount of copper in them —as a rule they are yellow.

Beta solutions, or crystal masses, are stronger than the preceding; but much less ductile. They are generally reddish.

Gamma solutions, or crystal masses, are very hard and brittle, and silvery white.

The various crystals can be dissolved in one another by special treatment, and variations in component structure therefore follow.

Alloys with above 64 per cent of copper and 36 per cent of zinc have copper-red alpha crystals intermixed with clear yellow alpha crystals.

Alloys with 39 to 31 per cent of copper and 61 to 69 per cent of zinc are silvery and brittle, consisting wholly of gamma crystals. They are called white brasses.

The brittleness which occurs in cold-worked common brasses is traceable largely to the evolution of gamma crystals therein, owing to the slow release of the zinc-rich parts from the copper-rich ones.

Disputes of an erudite nature have taken place among scientists concerning what really happens when brasses are made. The details of the summary which I give here appears to conform to the opinions of the majority of observers.

It is generally believed that the compounds $Cu_2 Zn_3$ and Cu Zn are formed, and that the first-named can be melted without decomposition, thereby remaining the same in substance when liquefied,

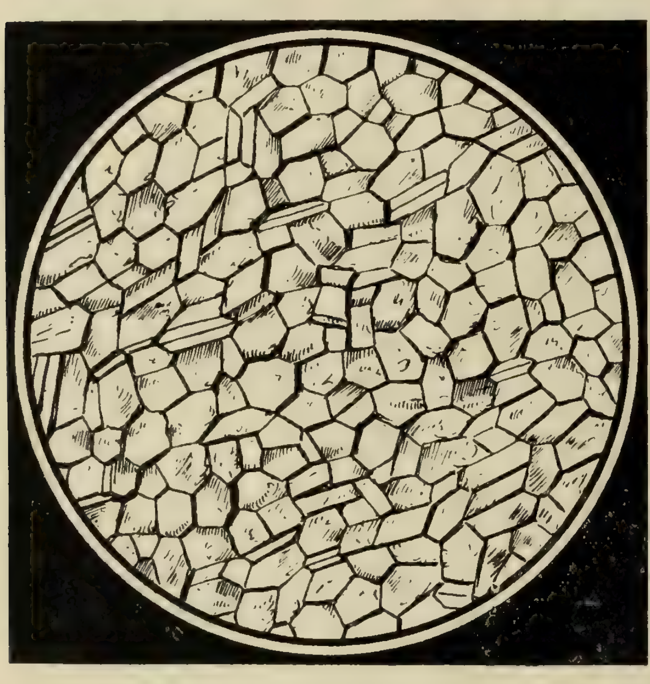

Fig. 2.—One-thirtieth inch of Muntz Metal after etching with nitric acid (in which it was stood), which discloses the brilliant underlying crystalline structure, in and upon which the specks of alpha, beta, and gamma metal rest—magnified.

and afterwards resolidified; whereas Cu Zn, when experiencing high temperatures, dissociates into $Cu_2 Zn_3$ and a mixture of pure copper and pure zinc crystals. $Cu_2 Zn_3$ consists of copper two "atoms" or parts, and zinc three "atoms" or parts; while Cu Zn consists of equal parts of copper and zinc.

Now, I will deal with the special brass known as Muntz metal. It is often alluded to as yellow metal, and is manufactured by Muntz's Metal Co. Ltd., French Walls, near Birmingham. It is valuable in every case where castings are unsuitable.

In standard volumes on metallurgy, the recipe for Muntz metal is given as between 63 to 56 per cent of copper and 37 to 44 per cent of zinc; but from information supplied to me by the makers themselves. I learn that its customary ingredients are 60 per cent of copper and 40 per cent of zinc. It is harder than brasses containing more copper.

In the early part of the 19th century Muntz metal was extensively used for the sheathing of wooden vessels, docks, and piers, to preserve them against the destructive action of sea water. For many more recent years, however, its use has, in the words of the manufacturers, in a letter to myself:—

"Been considerably extended, and it is now used in practically every branch of engineering and other work where the ordinary quality brass (not intended for brazing) can be put into work."

Among its more numerous applications are the following: Bolts, nuts, pins, spindles, wires, sheets, rollers for calico printing, and amalgamated plates for stamp batteries. A complete list of items made from it would need to occupy a few pages of this journal.

One of the notable properties of Muntz metal is that it can be worked in either a hot or cold condition. Men who manipulate brass will be able to fully appreciate this fact, as one form of brass may becomes brittle and useless when shaped in a cold condition, although it may be manageable when the metal is heated; while the same may be said in relation to the hot working of another brass, namely, that the heat spoils it, whereas it can be handled all right when cold.

Muntz metal with about 0.3 per cent of nickel is said to roll better than when its copper content is of the best refined quality. But if the slightest traces of arsenic remain, the merit conferred by the presence of the nickel is destroyed.

Some imitators have prepared Muntz metal containing 0.04 per cent of antimony (left as an impurity from the ores), and this has cracked under cold work.

Sterro metal is essentially Muntz metal with from 1 to 3 per cent of its zinc replaced by iron.

The anlysis of Muntz metal affords some very interesting spectacles.

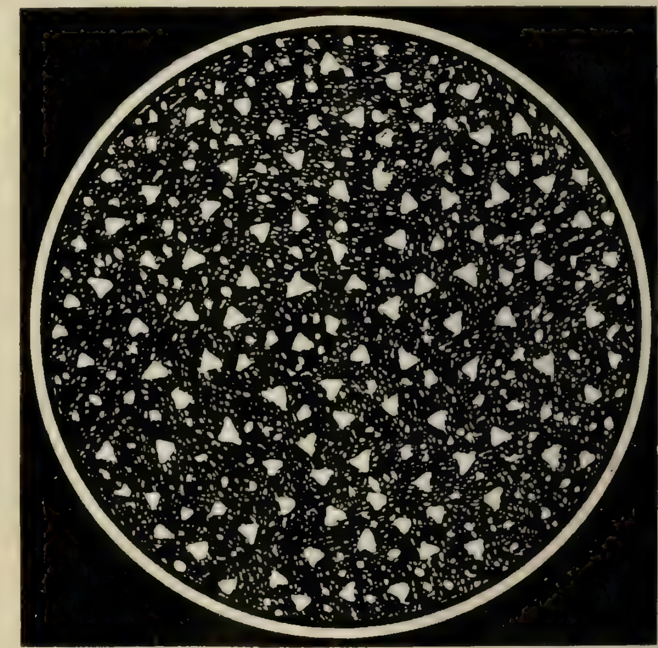

Fig. 3.—One-thirtieth inch of Muntz Metal, after etching with strong nitric acid. Brilliant white crystals, probably of gamma ingredient, are disclosed—magnified.

In Fig. 1 is shown a portion of a sheet of it after having been etched for a short time with strong chromic acid, which was later washed off. It is evident that the mass of alloy is built up of cohering, homogeneous, particles of ultra-minute dimensions—mere specks, indeed; and that these surround and enclose larger, more definite grains which they

actually help to produce. The darker, reddish parts are beta crystals, and the specks are similar but less rich in copper.

By standing Muntz metal for a few seconds in strong nitric acid the speckled layers round the fundamental crystals are cleared away, and a brilliant yellow surface of twinned alpha crystals is exposed as in Fig. 2.

If, instead, a drop of nitric acid is placed upon Muntz metal, a rich blue deposit (chiefly copper nitrate) splashed with green appears; and when this is washed off as completely as possible, there will be found some glistening, silvery white crystals in the dark, nitrated metal, as in Fig. 3, representing the uniformly scattered gamma, or zinc-rich portions. Dilute nitric acid only produces tiny, closely set, greenish spheres, but there is no doubt that the nucleus of each object is a gamma crystal.

Acids bring into prominence the hidden or basic crystallisations. Other figurings can be obtained according to the character of the etching, which is an orthodox practice; because certain particles are dissolved away, or darkened.

All these crystals lie embedded in and upon one another. Beta reddish crystals, or speck-like particles, have among them other crystals richer in zinc (alpha crystals); and this predominance gives the brass its fine golden-tan colour, which is resolved into a brilliant golden-yellow one when the metal is polished, and excess beta matter superficially removed. The white gamma crystals cannot then be properly seen in the highly reflecting substance. It is due to the satisfactory incorporation of hard grains among softer ones that Muntz metal possesses its remarkable features.

CANADA'S FUEL PROBLEMS.

(*Concluded from page 337.*)

Ultilising Lignite.

The means by which lignite and sub-bituminous coal may best be utilised is no academic problem for Canada. Over 93 per cent of the "actual" reserve of coal, and nearly 71 per cent of the "probable" reserves, in Western Canada are lignite or sub-bituminous. The problem is more than one of transport—the conveyance of coal from the bountiful West to the coal-less Centre. It is one of the transformation of a low-grade friable fuel into one that is hard and rich in carbon. Research is proceeding with a view to briquetting carbonised lignite into an artificial anthracite. Mr. White deals as follows with briquetting lignite, the production of pulverised coal, and the manufacture of carbo-coal:—

"In manufacturing carbonised lignite briquettes, the raw material is heated in closed retorts to drive off the moisture and nearly all volatile matter. The carbonised material is left behind as a coke, which contains about double the amount of fixed carbon contained in the raw lignite. This carbonised material is mixed with a binder and compressed in a briquetting machine. Subsequently the briquettes are waterproofed by heating the binder to coke it. Two tons of raw lignite produce one ton of briquettes. This, of course, practically doubles the amount of fixed carbon and ash. The question of the material to be used as a binder is an important one. Coal-tar pitch makes an excellent binder, but it is reported that the cost is high; the quantity available in Canada is also somewhat limited. Sulphite pitch, produced in the manufacture of paper pulp, has been successfully used as a binder in experimental work.

Pulverised Fuel.

"Pulverised coal was first utilised in cement plants and was found to be an excellent low-priced fuel of high efficiency. Later, it was applied in certain metallurgical processes, and during the last four years several United States railways have successfully operated locomotives with this class of fuel. To obtain the best results, about 85 per cent should pass a 200-mesh screen, and it should contain not more than 1 per cent of moisture. After being reduced to this high degree of fineness it is blown through a burner nozzle, the volatile gases of the pulverised coal igniting instantly. The fixed carbon is consumed by the heat of the volatiles, the flame resembling an oil or gas flame. By increasing or decreasing the supply of air or fuel, the operator regulates the supplies and has the operation under absolute control."

Carbo-coal.

"In the manufacture of carbo-coal, a high-volatile coal, after crushing, is distilled at a low temperature, 850 deg. Fah. to 900 deg. Fah. This first distillation yields gas and tar and a product called 'semi-carbo-coal,' which is high in carbon. The first distillation is continuous, the coal being agitated and mixed by a twin set of paddles. Thus all portions of the charge are uniformly distilled. After mixing the semi-carbo-coal with part of the pitch obtained from the tar produced in the first distillation, the mixture is briquetted. The briquettes are then subjected to a second distillation at about 1,800 deg. Fah., which yields carbo-coal, additional tar and gas, and a substantial amount of ammonium sulphate. Carbo-coal is dense, dustless, clean, uniform, in size and quality, and stands transportation without disintegration; its density is greater than that of coke, and more nearly approaches that of anthracite; the briquettes can be made in any size from ½ oz. to 5 oz., the larger sizes being better suited for locomotives and the smaller for domestic use; the yield of tar and ammonium sulphate is greater than in the by-product coking process."

Central Coking Plants.

In the view of Mr. James White, where a coking coal is obtainable at a reasonable price, the establishment of central coking plants near large centres of population seems to offer the maximum of advantage. Such a plant would produce a coke or artificial anthracite, gas for cooking or heating, coal tar which contains the elements entering into the manufacture of a whole series of valuable substances, benzol, toluol, and other raw materials for explosives, aniline oil whence aniline dyes are manufactured, and ammonia liquor from which is produced sulphate of ammonia, a valuable fertiliser. The coke thus produced can be used for all purposes for which anthracite is used. It requires a little more care in firing. Furnaces burning coke require a somewhat larger fire-box than for hard coal.

Whether such coke plant be municipal or private-owned, it offers what is, at the present time, the most promising solution of the fuel question for Saskatchewan, Manitoba, Ontario, and Quebec.

He adds that for large individual consumers, locomotives, and certain other uses, pulverised fuel promises to revolutionise present practice. "It is almost axiomatic," he writes, "that the less labour and cost expended on the preparation of coal fuel the better, and, other things being equal, the process that approximates most closely to this dictum is the most efficient and most economic."

(*Concluded.*)

COAL OUTPUT FOR 1919-1920.*

OFFICIAL ESTIMATES.

The following information in regard to the output of coal was supplied recently to the Coal Commission by the Coal Controller. It was based on the latest information obtainable.

The output for the first 20 weeks of 1919 was at the rate of 242,000,000 tons per annum, as compared with 287,000,000 tons in 1913.

The average number of men employed during the 20 weeks was 1,111,000, being exactly the same number as the average employed during the year 1913.

The average weekly output for the four weeks ending the 24th May, 1919, during which period there were no holidays and few stoppages, was 4,813,000 tons, or at the rate of, say, 238,000,000 tons per annum after allowing 5 per cent for holidays and stoppages.

The average weekly output of the six weeks ending the 15th March, during which conditions were fairly normal (with no holidays and few strikes or stoppages); the average output for the four weeks ending the 24th May, when similar conditions prevailed and the Sankey Wage was in operation; and the average nujmber of persons employed in the respective periods, are as follows:—

	6 weeks ending March 15th. Tons.	4 weeks ending May 24th. Tons.
Average number of persons employed	1,081,000	1,124,000
Average output per week	4,852,000	4,813,000
Output per man per week	4·5	4·3
Output per actual man shift	·92	·90

The percentage of absenteeism due to sickness, injury, and voluntary absence, shown as a percentage of the possible number of shifts which could have been worked, increased from an average of 10·7 per cent in 1913, to an average of 12·5 per cent in the first 20 weeks of 1919, and to an average of 13 per cent in the four weeks ending the 24th May.

The average number of days per week on which pits raised coal decreased from 5·58 in 1913 to 5·20 in the first 20 weeks of 1919.

The average output per man per period of four weeks decreased from 19·8 tons in 1913 to 16·8 tons in the first 20 weeks of 1919, and 17·1 tons in the four weeks ending the 24th May, during which period there were no holidays and few stoppages.

* *The Board of Trade Journal.*

The average output per actual man shift worked was one ton for the year 1913, ·89 of a ton for the first 20 weeks of 1919, and ·90 of a ton for the four weeks ending 24th May.

The estimated output for the year 1919, on the basis of the average weekly output of the first 20 weeks, and allowing for the reduced hours after the 16th July, is, say, 230,000,000 tons, or calculated on the weekly output for the first 20 weeks, the output for the remainder of the year being estimated on the average weekly output for the four weeks ending the 24th May, with an allowance of 5 per cent for holidays and stoppages, say, 228,000,000 tons.

The estimated output for 12 months from July, 1919, after the reduced hours have come into force is, say, 217,000,000 tons, calculated on the output of the first 20 weeks, or, say, 214,000,000 tons, calculated on the weekly output of the four weeks ending the 24th May, 1919, with an allowance of 5 per cent for holidays and stoppages.

The consumption of coal for inland purposes and bunkers was 210,000,000 tons in the year 1913 (the average for the five pre-war years was 209,000,000 tons), and for the year 1918 was 196,000,000 tons.

The exports of coal in the year 1913 were 77,000 000 tons, and in the year 1918, 34,000,000 tons. In order to provide approximately the same quantity of coal for inland consumption and bunkers for 12 months from July, 1919, all present restrictions on consumption must be fully maintained, and, in addition, exports must be reduced from a rate of 34,000,000 tons per annum to a rate of 23,000,000 tons per annum

It is estimated that the deficiency on the working of the industry on the basis of the estimated outputs given for the period of 12 months from July next, after providing for the guaranteed profits to owners at the rate of 1s. 2d. per ton will be about £46,600,000, equal to 4s. 3d. per ton of output. For the calendar year 1919 it is estimated that the deficiency will be £37,000,000.

COAL OUTPUT SINCE 1913.

Table showing the output of coal, number of persons employed, and average output per man from 1913 to date:—

Period.	Average number of persons employed.	Output. Tons.	Average output per man per for four weeks.
Year:—			
1913	1,111,000	287,412,000	19·8
1914	1,117,000	265,643,000	18·3
1915	952,000	253,179,000	20·4
1916	956,000	255,846,000	20·4
1917	993,000	248,041,000	19·2
1918	961,000	226,557,000	18·1
Four weeks ending:—			
Feb. 1, 1919	1,065,000	18,315,000	17·2
March 1	1,098,000	19,470,000	17·8
March 29	1,106,000	18,678,000	16·9
April 26	1,124,000	17,272,000	15·4
May 24	*1,124,000	19,251,000	17·1
First 20 weeks in 1919	1,111,000	92,986,000	16·8

* The figures for May are not yet accurately known, and those for April 26th have been used. It should be noted, however, that the number of persons employed is probably an increasing figure for the month of May.

Note.—The Sankey Wage took effect as a current increase in the week ending April 26, arrears having been paid prior to that date.

OUTPUT PER MAN.

The following table gives the total output and average output per man for six separate weeks before Easter, 1919, during which conditions were fairly normal (with no holidays and few strikes or stoppages), and the corresponding figures for each of the four weeks ending May 24th, when similar conditions prevailed and the Sankey Wage was in operation :—

Week ending	Number Employed. Tons.	Total Output. Tons	Average per man. Tons.
February 8....	1,065,000	4,875,000	4·6
February 15...	1,065,000	4,884,000	4·6
February 22...	1,065,000	4,826,000	4·5
March 1....	1,098,000	4,885,000	4·5
March 8....	1,098,000	4,800,000	4·4
March 15....	1,098,000	4,840,000	4 4
Average for above six weeks ..	1,081,500	4,852,000	4·5
May 3....	1,124,000	4,729,000	4·2
May 10....	1,124,000	4,802,000	4·3
May 17....	1,124,000	4,834,000	4·3
May 24....	1,124,000	4,886,000	4·3
Average for above four weeks	1,124,000	4,813,000	4·3

The following table shows the average output per actual man shift from 1913 to date, with the percentage of absenteeism (*i.e.*, the number of shifts lost through sickness, injury, etc., and through voluntary absence from work) stated as a percentage of the possible number of shifts which could have been worked :—

Period.	Aver. output per actual man shift. Tons.	Percentage of Absenteeism.	Aver. No. of days per week on which pits raised coal.
Year 1913..........	1·0	10·7	3·58
1914..........	·98	10·3	5·23
1915..........	1·02	9·9	5 58
1916..........	1·00	9·7	5·68
1917..........	·96	8·9	5 48
1918..........	·94	11·0	5 46
Four weeks ending :—			
Feb. 1, 1919	·88	10·8	5·47
Mar. 1..........	·90	12·5	5·65
Mar. 29..........	‘89	13·3	5·47
April 26	·87	13·0	5·06
May 24..........	·90	13·0*	5·46†
First 20 weeks in 1919	·89	13 0	5·42

THE ESTIMATED OUTPUT OF COAL FOR 1919.

1.—*Calculated on the basis of the average weekly output of coal for the first* 20 *weeks of* 1919 (*ending 24th May*).

	Tons.
Output for the first 20 weeks in 1919......	92,986,000
Estimated output for the year 1919 on the basis of the present working-hour-day if the same rate of output is maintained..	241,764,000
Deduct 10 per cent from the proportion of output for the period 16th July to 31st December, 1919, to allow for the shortening of the working day by one hour	11,150,000
Estimated output for the year 1919	230,606,000

* May figures not being known accurately the April figures are taken.

† The average for 1918; exact figures not yet available.

2.—*Calculated on the basis of the average weekly output for the four weeks from the week ending 3rd May,* 1919, *to the week ending 24th May*, 1919 (*inclusive*).

	Tons.	Tons.
Output for first 20 weeks in 1919		92,986,000
Estimated output for the remaining 32 weeks of 1919, calculated on the weekly rate of output for the four-weekly period ending 24th May (viz., 4,813,000 tons per week)....	154,016,000	
Deduct 5 per cent as an allowance for holidays and stoppages	7,700,000	
		146,316,000
Estimated output for the year 1919 on the basis of the present working-hour day		239,302,000
Deduct 10 per cent from the proportion of output for the period 16th July to 31st Dec., 1919, to allow for the shortening of the working day by one hour		11,045,000
Estimated output for the year 1919..		228,257,000

ESTIMATE FOR 12 MONTHS FROM 16TH JULY, 1919, TO 15TH JULY, 1920.

1.—*Calculated on the basis of the average weekly output of coal for the first* 20 *weeks of* 1919 (*ending 24th May*).

	Tons.
1.—Output for the first 20 weeks in 1919..	92,986,000
2.—Estimated output for 52 weeks on same basis	241,764,000
3.—Deduct 10 per cent to allow for the shortening of the working day by one hour from 16th July,1919............	24,176,000
4.—Estimated output from 16th July, 1919, to 15th July, 1920	217,588,000

2.—*Calculated on the basis of the average weekly output for the four weeks from the week ending 3rd May,* 1919, *to the week ending 24th May*, 1919 (*inclusive*).

	Tons.
1.—Average weekly output for the four weeks from the week ending 3rd May, 1919..	4,813,000
2.—Estimated output for 52 weeks on the same basis, allowing 5 per cent for holidays and stoppages	237,732,000
3.—Deduct 10 per cent to allow for the shortening of the working day by one hour from 16th July, 1919	23,776,000
4.—Estimated output from 16th July, 1919, to 15th July, 1920	213,986,000

OUTPUT, CONSUMPTION AND EXPORT.

Statement showing output, inland consumption, and export of coal for the years 1913-1918, with an estimate for 1919, and for July, 1919, to July, 1920 :—

Period.	*a* Output. Tons.	Inland Consumption and Bunkers. Tons.	ETport. Tons.
1913	287,412,000	210,105,000	77,307,000
1914	265,643,000	203,185,000	62,458,000
1915	253,179,000	206,857,000	46,322,000
1916	255,846,000	213,917,000	41,929,000
1917	248,041,000	209,607,000	38,434,000
1918	226,557,000	*d*195,937,000	34,420,000
1919(estimated)	*b*230,606,000	*cd*198,806,000	28,000,000
16th July, 1 919, to 15th July, 1920 (estimated)	*b*217,588,000	*c*194,588,000	23,000,000

NOTES.—(*a*) The figures of output have been compiled from returns furnished by colliery proprietors. The returns supplied by each coal mine, so far as available, vary slightly from the figures given, but the variation is negligible. (*b*) Both these figures of estimated output are calculated on the basis of the weekly average of the figures available for the first 20 weeks of 1919. (*c*) With present restriction fully maintained. (*d*) Stocks were depleted during 1918 by 3,800,000 tons, so that the consumption out of output for 1918 was only 192,137,000 tons. It is proposed to replace these necessary stocks in 1919, and the coal available for actual consumption in 1919 is therefore less than the actual output less exports.

ESTIMATED DEFICIENCY FOR 12 MONTHS FROM 16TH JULY.

Statement of estimated deficiency on the working of the coal industry for a period of 12 months from the 16th July, 1919, to the 15th July, 1920, inclusive.

The profit of £54,000,000 estimated in the interim Sankey Report for the current year was arrived at by assuming an output of 264,000,000 tons for the year 1919 (on the basis of the present working-hour-day) at a profit of 4s. 1d. per ton.

The profit of 4s. 1s. per ton was based on an ascertained profit of 3s. 7d. per ton for the quarter ended 30th September, 1918, increased by 6d. as an additional ton-profit arising out of the reduction in overhead charges following an increased output, after allowing for the wages of the additional men.

The following estimate is also based on the ascertained profit of 3s. 7d. per ton in relation to the output as now estimated for a period of 12 months from the 16th July, 1919, which is the date on which the shortenng of the working day by one hour comes into operation.i

	Equals per ton. s.	d.
Ascertained profit for the quarter ended 30th September, 1918, on the basis of an output at the rate of 228,000,000 tons per annum, the average number of persons employed being 961,000	3	7
Deduct for wages of 163,000 additional persons employed at the pre-Sankey rate (an average of, say, £3 per week $=\frac{£489,000\times 52}{228,000,000}$ ....(say)	2	3
	1	4
(N.B.—The latest figure available of the number of persons employed is 1,124,000 on the 26th April, 1919, and by deducting the 961,000, the additional 163,000 is obtained.)		
Deduct for the extra cost of overhead charges due to a decrease in output from 228,000,000 tons to 217,000,000 tons ....(say)	0	5
	0	11
Deduct the Sankey wage of £30,000,000, which, on an output of 217,000,000 tons, works out at, say.................................	2	9
Loss	1	10

	Equals £
The loss on an output of 217,000,000 tons at 1s. 10d. per ton	20,000,000
*Add estimated loss of profit on export trade due to reduction of exports from 34,000,000 tons per annum in 1918 to 23,000,000 tons per annum as estimated (say)	11,000,000
Add the guaranteed profits to owners of 1s. 2d. per ton on an output of 217,000,000 tons................................	12,600,000
Add compensation to owners for working under the instructions of the Controller mines that would otherwise be abandoned	3,000,000
Estimated deficiency on 12 months' work from the 16th July, 1919	46,600,000

Equals 4s. 3d. per ton.

The above estimate is based on the following assumptions:

(1) That the present price of coal to consumers is maintained unaltered.

(2) That in order to provide about 23,000,000 tons of coal per annum for export (as compared with 77,000,000 tons in 1913 and 34,000,000 tons in 1918) the present restrictions on the use of coal for inland consumption are maintained.

In order to meet the above estimated deficiency and to provide a small margin, the price of coal to the consumer must be raised by about 4s. 6d. per ton unless the deficiency is paid by the taxpayer.

ESTIMATED DEFICIENCY ON WORKING FOR 1919.

This estimate is calculated on the same basis as that adopted for the purpose of the Sankey Interim Report.

	Equals £
Output for the calendar year 1919, estimated at the actual rate of output for the first 20 weeks of 1919, say, 242,000,000 tons.	
Ascertained profit on the basis of the quarter ended 30th September, 1918, for an output at the rate of 228,000,000 tons per annum at 3s. 7d. per ton..............	41,000,000
Deduct for wages of 150,000 additional men for 12 months at, say, £3 per week....	23,400,000
	17,600,000

*It is estimated that owing to the removal of the privileged export prices to the Allies, the present rate of profit per ton of coal exported will probably be maintained, but the total profit on exports will be reduced in proportion to the reduction in the quantity of coal exported

Add profit on additional output of 14,000,000 tons at 3s. 7d. per ton..........(say)		£2,500,000
		20,100,000
Add for saving on overhead charges per ton due to increase of output from 228,000,000 tons to 242,000,000 tons per annum (242,000,000 tons at 5d. per ton)..(say)		5,000,000
		25,100,000
*Deduct to allow for reduced profits on export trade owing to reduction of exports from 34,000,000 tons in 1918 to 28,000,000 tons in 1919		6,000,000
Total profits for 1919 on the basis of the pre-Sankey wages and hours..........		19,100,000
Owners' guaranteed profits (242,000,000 tons at 1s. 2d. per ton)................		14,000,000
Balance		5,100,000
Additional charges —	£	
Sankey wage.............	30,000,000	
Reduction of working hours.	12,000,000	
		42,000,000
Deficiency for 1919		£36,900,000

REINFORCED CONCRETE: THE "CLAUGHTON IDEAL" BEAM THEORY.

By JAMES CLAUGHTON.

(*Continued from page 244.*)

In our preliminary calculations we assumed stresses of 600 and 16000 lbs. per square inch for concrete and steel respectively. It will be clear that calculation 7 must be modified as follows :—

As 600 : 16000 : : 513·5 : x

$x = 13690$ lbs. Substituting this value in formula :

$$A_s = \frac{M}{t\left(d - \frac{n}{3}\right)} = \cdot 4505 \text{ square inches.}$$

If the revised figures 513·5 and 13960 are correct, then total tension = total compression.

$$A_s t = \frac{c}{2}bn$$

$$\cdot 4605 \times 13690 = \frac{513\cdot 5}{2} \times 5\cdot 84 \times 4\cdot 2048$$

6304 = 6304 ; $\therefore$ they are correct values.

If the above value 6304 be multiplied by a, it should equal M. Thus, 6304 $\times$ 10·28 = 64800 inch-lbs., which is the bending moment $\frac{WL}{8}$. Again the values are proved to be correct.

Re calculation (5). $\delta = \frac{AL_c}{E_c \cdot J_c} = \frac{5WL^3}{384E_cI_c}$

*It is estimated that owing to the removal of the privileged export prices to Allies, the present rate of profit per ton of coal exported will probably be maintained, but the total profit on exports will be reduced in proportion to the reduction in the quantity of coal exported.

$$I_c = \frac{bn^3}{3} + mA_s(d-n)^2$$
$$= \frac{5\cdot 84 \times 4\cdot 2^3}{3} + 15 \times \cdot 4605 \times 7\cdot 48^2$$
$$= 142 + 385$$
$$= 527$$

but I_c we require should equal $\frac{Mn}{c} = \frac{64800 \times 4\cdot 2}{513\cdot 5}$
$$= 532$$

and I_c should also equal $\frac{M(d-n)m}{t} = \frac{64800 \times 7\cdot 48 \times 15}{13690}$
$$= 532$$

From these three results we can safely state that for all practical purposes they are in agreement.

Let $I_c = 532$ and substitute this value for I_c in formula $\frac{5WL^3}{384E_cI_c}$ for deflection :

$\therefore \delta = \cdot 033$ inches.

NOTES.—The reason why we have had to modify the stresses for concrete and steel is on account of the maximum shear at any section being limited to $60ab$ by the regulations of certain authorities.

This verification proves that this value is too low, because it means that we are compelled to work to a higher factor of safety than four.

If steel constructional engineers are allowed to work to a factor of four, reinforced concrete engineers should also be allowed to work to a factor of four ; because do not all structures of this material increase in strength in proportion to the time they have been built. The author thinks that all reasonable engineers will agree with him in stating that this limiting of shear stress puts reinforced concrete engineers in an unfair position when competing against builders of steel frame structures.

In all cases, by accommodating the compressive and tensile stresses to suit the given limiting values for shear stress, we can prove the correctness of the theory for all reinforced concrete work as given in this thesis.

From the foregoing remarks it will be obvious to all that although we are given 600 and 16000 lbs. per square inch as the working stresses for concrete and steel respectively when a standard 1 : 2 : 4 mixture is used, they are really only nominal figures, for actually we must not use them. It also follows that we cannot calculate our beams right away from the recognised formulæ; nearly always we must modify our preliminary figures.

This thesis has for its main object to deduce a set of formulæ that will give us a quick and accurate solution right away. *We do ultimately attain this object.*

A further point that requires some explanation is the adhesion of concrete to steel. The usual wording figure is 100lbs. per square inch of contact surface. It will be evident that some anchorage must be provided to take the tensile force in the steel, and this anchorage must take one or more of the following forms :—

Firstly.—The bars must be continued in the beam for a length sufficient to ensure that the adhesion of the concrete to the steel at least equals the maximum force produced in the steel.

Secondly.—By forming a suitable hook, fishtail or other convenient anchorage at the ends of the bars'

Thirdly.—By a combination of both of the foregoing.

We are all aware of the fact that the maximum stresses in the steel occur at the points of maximum bending moments, and that these stresses vary to a minimum as they approach the points of contraflexure.

We can, conditions permitting, vary the cross-sectional area of steel as required throughout the beam. This matter must in all cases be decided by an expert.

The drawing given on Plate 2 will be found, I hope, self-explanatory, especially as regards anchorage.

(*To be continued*).

DIESEL ENGINE USERS' ASSOCIATION—JUNE MEETING.

At the meeting of the Diesel Engine Users' Association in June, the President, Mr. Napier Prentice, reported that application had been made for a Government grant in connection with the carrying out of research work and tests on liquid fuels for Diesel and semi-Diesel engines, more especially on those fuels which are produced in this country, and that he hoped to be in a position to give further information on this matter at the next meeting.

The application of the Household Fuel and Lighting Order, 1918, to electricity supply undertakings using oil as fuel in place of coal, was discussed. It was pointed out that the application of the order to such undertakings at the present time was placing an unnecessary check on the output of electrical energy in the districts supplied by those undertakings, and that there could be no reason for consumers of electricity for lighting, heating and power purposes to be inconvenienced and harassed by restrictions in any area in which the supply of electricity was not derived from the burning of coal in furnaces under boilers. It was suggested that, on the contrary, every encouragement should be given to developing as speedily as possible the greatest use of electric power in such areas of supply. A resolution to that effect was unanimously passed, copies of which were to be sent to the Board of Trade, to the Controller of Coal Mines, and to the Chief Electricity Commissioner Designate.

Mr. Geo. E. Windeler read a short paper on "A Method of Checking the Alignment of Diesel Engine Shafts, and a means of Proving if a Shaft is actually Bedding in its Bearings." He explained that he did not claim any novelty for his system, but that if other people knew of it previously they had apparently not made much of it, and he claimed that with the use of a suitable instrument which he had designed any engine user could instruct his engine driver in making good, practical use of the method. The end movement of the shaft, in excess of the actual mechanical clearance allowed, was an indication that springing of the crankshaft was taking place for want of proper support, and that actually the shaft was being extended and contracted in length by the opening and closing of the gap between the crank webs. A measure of this distortion was taken by measuring with a suitable instrument the distance between the crank webs when the crank pin was on the top centre and when it was on the bottom centre. A few thousandths of an inch difference in these two measurements indicated the shaft was out of line. The method was especially valuable in regard to checking the alignment of outboard bearings. The instrument used was exhibited at the meeting. The method enabled a check to be taken at any time as to whether a shaft was properly supported or otherwise, without removing any parts. The method was also valuable when rebedding a new bearing into position, as it enabled the refit to take place without removing other parts from the engine, and with a certainty that the whole of the bearings would be accurately in line.

STANDARDISATION OF CHAINS

The unprecedented demands of the Allied Governments for driving chains for all purposes during the period of the war made it necessary for the British driving chain manufacturers to collaborate in order to use the whole of their resources to the best advantage. As a result, the needs were met, both as regards quantity of production and quality of products. The benefits accruing from co-operation were so marked that a permanent Association has now been formed.

The main object of the Association is to foster and develop the use and application of chain gearing, the value of which is not yet fully appreciated by power users. In view of this, and in the face of competition with other forms of transmission, it is the policy of the Association to keep down the cost of chain driving to the user. This will be attained by:—

1. Standardisation of chains, wheels, and chain-wheel cutters, to ensure interchangeability.
2. Elimination of unnecessary sizes of chains, which have been a source of confusion and difficulty to the user.
3. The increase in output resulting from the above.
4. The more comprehensive research made possible by co-operation.

Further, it is confidently anticipated that the policy of the Association, as set out above, will enable British driving chain manufacturers and their customers to secure a larger share of overseas business than hitherto.

Alfred Appleby Chain Co. Ltd.,
Tilton Road, Birmingham.
Brampton Bros. Ltd.,
Oliver Street Works, Birmingham.
"The Coventry" Chain Co. Ltd.,
Spon End Works, Coventry.
Hans Renold Ltd.,
Didsbury, Manchester.

Address—
Association of British Driving Chain Manufacturers,
Bassishaw House, Basinghall Street,
London, E.C. 2.

Grits and Grinds for May (the house journal of the Norton Company, Worcester, Mass., U.S.A.) contains an article by P. A. Bridgman entitled "Internal Grinding in Locomotive Shops," showing the advantage which articles fiinished on internal grinding machines have over those which heretofore have been turned, reamed, and lapped. The article written under the heading "Alundum Tile—Slip proof," shows the popularity of this tile, and also gives illustrations of its adaptability to various kinds of stairs. In "Grinding Kinks," by Howard W. Dunbar, an illustration is given showing how the problem of valve-seat grinding has been solved in one factory, and may prove very valuable to those seeking a method to remedy this difficulty.

Weights of Lengths of Rolled Steel Sections.

Beam 8in. × 5 in. × 26½ lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 1 13·0	4 2 26·0	7 0 11·0	9 1 24·0	11 3 9·0	14 0 22·0	16 2 7·0	0 18 3 20·0	1 1 1 5·0	0
1	0 0 26·5	2 2 11·5	4 3 24·5	7 1 9·5	9 2 22·5	12 0 7·5	14 1 20·5	16 3 5·5	0 19 0 18·5	1 1 2 3·5	1
2	0 1 25·0	2 3 10·0	5 0 23·0	7 2 8·0	9 3 21·0	12 1 6·0	14 2 19·0	17 0 4·0	0 19 1 17·0	1 1 3 2·0	2
3	0 2 23·5	3 0 8·5	5 1 21·5	7 3 6·5	10 0 19·5	12 2 4·5	14 3 17·5	17 1 2·5	0 19 2 15·5	1 2 0 0·5	3
4	0 3 22·0	3 1 7·0	5 2 20·0	8 0 5·0	10 1 18·0	12 3 3·0	15 0 16·0	17 2 1·0	0 19 3 14·0	1 2 0 27·0	4
5	1 0 20·5	3 2 5·5	5 3 18·5	8 1 3·5	10 2 16·5	13 0 1·5	15 1 14·5	17 2 27·0	1 0 0 12·5	1 2 1 25·5	5
6	1 1 19·0	3 3 4·0	6 0 17·0	8 2 2·0	10 3 15·0	13 1 0·0	15 2 13·0	17 3 26·0	1 0 1 11·0	1 2 2 24·0	6
7	1 2 17·5	4 0 2·5	6 1 15·5	8 3 0·5	11 0 13·5	13 1 26·0	15 3 11·5	18 0 24·5	1 0 2 9·5	1 2 3 22·5	7
8	1 3 16·0	4 1 1·0	6 2 14·0	8 3 27·0	11 1 12·0	13 2 25·0	16 0 1·0	18 1 23·0	1 0 3 8·0	1 3 0 21·0	8
9	2 0 14·5	4 1 27·5	6 3 12·5	9 0 25·5	11 2 10·5	13 3 23·5	16 1 8·5	18 2 21·5	1 1 0 6·5	1 3 1 19·5	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs. 2·20	lbs. 4·41	lbs. 6·62	lbs. 8·83	lbs. 11·04	lbs. 13·25	lbs. 15·45	lbs. 17·66	lbs. 19·87	lbs. 22·08	lbs. 24·29	lbs. 26·5	Weight.

Weights of Lengths of Rolled Steel Sections.

Beam 8 in. × 5 in. × 26½ lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	1 3 2 18	2 7 1 8	3 10 3 26	4 14 2 16	5 18 1 6	7 1 3 24	8 5 2 14	9 9 1 4	10 12 3 22	0
10	0 2 1 13	1 6 0 3	2 9 2 21	3 13 1 11	4 17 0 1	6 0 2 19	7 4 1 9	8 7 3 27	9 11 2 17	10 15 1 7	10
20	0 4 2 26	1 8 1 16	2 12 0 6	3 15 2 24	4 19 1 14	6 3 0 4	7 6 2 22	8 10 1 12	9 14 0 2	10 17 2 20	20
30	0 7 0 11	1 10 3 1	2 14 1 19	3 18 0 9	5 1 2 27	6 5 1 17	7 9 0 7	8 12 2 25	9 16 1 15	11 0 0 5	30
40	0 9 1 24	1 13 0 14	2 16 3 4	4 0 1 22	5 4 0 12	6 7 3 2	7 11 1 20	8 15 0 10	9 18 3 0	11 2 1 18	40
50	0 11 3 9	1 15 1 27	2 19 0 17	4 2 3 7	5 6 1 25	6 10 0 15	8 3 3 5	8 17 1 23	10 1 0 13	11 4 3 3	50
60	0 14 0 22	1 17 3 12	3 1 2 2	4 5 0 20	5 8 3 10	6 12 2 0	8 6 0 18	8 19 3 8	10 3 1 26	11 7 0 16	60
70	0 16 2 7	2 0 0 25	3 3 3 15	4 7 2 5	5 11 0 23	6 14 3 13	8 8 2 3	9 2 0 21	10 5 3 11	11 9 2 3	70
80	0 18 3 20	2 2 2 10	3 6 1 0	4 9 3 18	5 13 2 8	6 17 0 26	8 10 3 16	9 4 2 6	10 8 0 24	11 11 3 16	80
90	1 1 1 5	2 4 3 23	3 8 2 13	4 12 1 2	5 15 3 21	6 19 2 11	8 13 1 1	9 6 3 19	10 10 2 9	11 14 1 1	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs. 11 16 2 12	t. c. q. lbs. 23 13 0 24	t. c. q. lbs. 35 9 3 8	t. c. q. lbs. 47 6 1 20	t. c. q. lbs. 59 3 0 4	t. c. q. lbs. 70 19 2 16	t. c. q. lbs. 82 16 1 0	t. c. q. lbs. 94 12 13 12	t. c. q. lbs. 106 9 1 24	t. c. q. lbs. 118 6 0 8	Weight.

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 6 in. × 5 in. × 26 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 1 8	4 2 16	6 3 24	9 1 4	11 2 12	13 3 20	16 1 0	0 18 2 8	1 0 3 16	0
1	0 0 26	2 2 6	4 3 14	7 0 22	9 2 2	11 3 10	14 0 18	16 1 26	0 18 3 6	1 1 0 14	1
2	0 1 24	2 3 0	5 0 12	7 1 20	9 3 0	12 0 8	14 1 16	16 2 24	0 19 0 4	1 1 1 12	2
3	0 2 22	3 0 2	5 1 10	7 2 18	9 3 26	12 1 6	14 2 14	16 3 22	0 19 1 2	1 1 2 10	3
4	0 3 20	3 1 0	5 2 5	7 3 16	10 0 24	12 2 4	14 3 12	17 0 20	0 19 2 0	1 1 3 8	4
5	1 0 18	3 1 26	5 3 6	8 0 14	10 1 22	12 3 2	15 0 10	17 1 18	0 19 2 26	1 2 0 6	5
6	1 1 16	3 2 24	6 0 4	8 1 12	10 2 20	13 0 0	15 1 8	17 2 16	0 19 3 24	1 2 1 4	6
7	1 2 14	3 3 22	6 1 2	8 2 10	10 3 18	13 0 26	15 2 6	17 3 14	1 0 0 22	1 2 2 2	7
8	1 3 12	4 0 20	6 2 0	8 3 8	11 0 16	13 1 24	15 3 4	18 0 12	1 0 1 20	1 2 3 0	8
9	2 0 10	4 1 18	6 2 26	9 0 6	11 1 14	13 2 22	16 0 2	18 1 10	1 0 2 18	1 2 3 26	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	0 2·16	0 4·33	0 6·5	0 8·66	0 10·83	0 13·0	0 15·16	0 17·33	0 19·5	0 21·67	0 23·83	0 26	

Weights of Lengths of Rolled Steel Sections.

Beam 6 in. × 5 in. × 26 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	1 3 0 24	2 6 1 20	3 9 2 16	4 12 3 12	5 16 0 8	6 19 1 4	8 2 2 0	9 5 2 24	10 8 3 20	0
10	0 2 1 8	1 5 2 4	2 8 3 0	3 11 3 24	4 15 0 20	5 18 1 16	7 1 2 12	8 4 3 8	9 8 0 4	10 11 1 0	10
20	0 4 2 16	1 7 3 12	2 11 0 8	3 14 1 4	4 17 2 0	6 0 2 24	7 3 3 20	8 7 0 16	9 10 1 12	10 13 2 8	20
30	0 6 3 24	1 10 0 20	2 13 1 16	3 16 2 12	4 19 3 8	6 3 0 4	8 2 1 0	8 9 1 24	9 12 2 20	10 15 3 16	30
40	0 9 1 4	1 12 2 0	2 15 2 24	3 18 3 20	5 2 0 16	6 5 1 12	8 4 2 8	8 11 3 4	9 15 0 0	10 18 0 24	40
50	0 11 2 12	1 14 3 8	2 18 0 4	4 1 1 0	5 4 1 24	6 7 2 20	8 6 3 16	8 14 0 12	9 17 1 8	11 0 2 4	50
60	0 13 3 20	1 17 0 16	3 0 1 12	4 3 2 8	5 6 3 4	6 10 0 0	8 9 0 24	8 16 1 20	9 19 2 16	11 2 3 12	60
70	0 16 1 0	1 19 1 24	3 2 2 20	4 5 3 16	5 9 0 12	6 12 1 8	8 11 2 4	8 18 3 0	10 1 3 24	11 5 0 20	70
80	0 18 2 8	2 1 3 4	3 5 0 0	4 8 0 24	5 11 1 20	6 14 2 16	8 13 3 12	9 1 0 8	10 4 1 4	11 7 2 0	80
90	1 0 3 16	2 4 0 12	3 7 1 8	4 10 2 4	5 13 3 0	6 16 3 24	8 16 0 20	9 3 1 16	10 16 2 12	11 9 3 8	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	11 12 0 16	23 4 1 4	34 16 1 20	46 8 2 8	58 0 2 24	69 12 3 12	81 5 0 0	92 17 0 16	104 9 1 4	116 1 1 20	

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

COAL INCREASE AND INDUSTRY.

SIR AUCKLAND GEDDES statement as to the increase of 6s. per ton on the price of coal may no doubt cause a shock to the ordinary citizen, and it is of interest to note that the Federation of British Industries, in a statement handed in to the Coal Commission, outlined what was then an estimate of the probable effect on the price of coal after the granting of the miners' demands.

It was suggested that the estimate was purely assumption by certain members of the Commission, but to-day that estimate is an actual realisation. The seriousness of this increase cannot be over-estimated, as the cost of fuel plays such a considerable part in many of our prime industries.

In the statement above mentioned a table was given summarising the effect of a direct fuel increase of many types of industry, and it may be of interest to detail some of the chief. The following are of particular interest as representative of products used in the building trade:—

The Steel increase: 24s. per ton.
Bricks increase: 5 per cent.
Drain Pipes, etc., increase: 6s. per ton.
Glass increase from 5 to 10 per cent.

As already the cost of building materials seems to prohibit construction from an economic standpoint, this increase will simply intensify the difficulties of solving the housing question. Food prices are also bound to be affected, directly as manufactured articles, and indirectly through increased freightage charges. The increase in the price of coal will become very evident to the domestic consumer, but it is not fully appreciated what the increase will mean to Industry, and accordingly the following table may help the average citizen to appreciate the burden which will have to be faced by our manufacturers.

Industry.	Increased charge on production cost in Pounds.
Mining ...	5,639,700
Iron and Steel, Shipbuilding and Engineering	4,746,900
Other Metal Trades	351,300
Textiles	3,021,600
Clothing	250,500
Food and Drink	1,223,100
Chemical and Allied	1,363,500
Paper and Allied	653,100
Leather and Allied	178,800
Timber	195,000
Building, Clay, and Allied	2,337,000
Public Utility Services	1,097,400

Calculated from Tables supplied to the Coal Conservation Committee. (See Report, Appendix A.)

This increased production charge would entail increases in the selling prices of the manufactured article, and whilst space will not allow a full statement of particular cases, the following general summary may be taken as illustrative of the effect of a 20 per cent increase in fuel cost:—

Engineering products will show an increase of from 3 per cent to 10 per cent.

Textiles will show an increase of from 3 per cent to 4 per cent.

Paper will show an increase of 9s. per ton.

Other Metal trades will show an increase of from 2 per cent to 6 per cent.

Food and Drink—Salt, for instance—an increase of 6s. per ton.

Chemicals will show an increase of 10 per cent.

Public Utility Service—Gas and Electricity—10 per cent.

Many of these industries before the war had large export trades, in which the margin of profit was very narrow, owing to the keenness of competition with foreign producers. This fine margin of profit may become non-existent, owing to the higher cost of production, at a time when, more than ever, it is necessary for the nation to build up a huge export trade, in order to place the financial stability of the country on a thoroughly sound basis. The trade cannot be carried on at a loss, and the country cannot live for long on its capital.

Accordingly the seriousness of the position should be brought to the notice of every individual in the country, as the effect of a loss of our overseas trade would be political, social, and economic chaos. Unemployment and hardship, which would be felt more acutely by the working classes in the first place, would finally result in the negation of all that national unity, built up during the Great War by the travail of the nation, and without which the final victory would have been impossible.

THE TARIFF QUESTION.

IN many quarters, literary and otherwise, it is being urged that a discriminative tariff should now be directed against enemy "actuall," and "enemy in spe" goods. How, let us ask, is this desired result to be obtained? Especially as regards the engineering branch? By the measure of recognition and encouragement necessary to make this branch of industry a permanent institution in our country. Much machinery and many engineering specialities have been admitted to England in the past with low duty, and, in some cases, with no duty at all. We, as a nation, have certainly paid may times over for that in the past months of the war. It would have been wiser, easier, and far more economical to have paid as we went, and over a long period of years, and to have, by such a method, fostered and established a permanent industry of still greater national importance, and, furthermore, in this way, have avoided a situation of still greater peril to our nation.

The valuable part that engineering has played during the war has brought the industry into prominence and resulted in a recognition of it, on an increased scale, as an important and distinctive industry. Much attention was dedicated by the Press, for instance, to "tanks" and "whippets," thus drawing the attention of the public to the industry in a very marked way. A thing may be decidedly important, but its prominence will depend upon appreciation and knowledge on the part of the general public of its actual value. The war has given a publicity to engineering that thousands of pounds spent in advertising could never have achieved. Let us profit by this, and at the same time protect our industry by means of protective tariffs—in fact, let us do all and everything to keep the foreigner "out."

MOTORCYCLE DESIGN.

By D. S. Heather, B.Sc.

(*Continued from page 312.*)

The lubrication system of the average British motorcycle engine is crude in the extreme. That this should be so is surprising, for no engine can be expected to give reasonable service unless its lubrication system is entirely satisfactory. The essential requirement, of course, is the provision of a correct supply of cool, pure oil to each bearing under all conditions of speed and load. It is no use supplying overheated oil, or oil contaminated by carbon, and it is very little better to supply cool, pure oil in incorrect quantities, whether such quantities are too large or too small. Too large a supply will cause carbonisation and undue piston friction due to the shearing of a heavy oil film, and too small a supply will, of course, be disastrous. The author has no hesitation in saying that, so far from complying with the three conditions mentioned above, the lubrication system on the usual motorcycle provides an incorrect supply of overheated, impure oil at all times, so that it does not comply with even one of the three requirements.

The method usually adopted is, of course, to pass oil into the crankcase by some means or other, and allow it to find its way to the bearing surfaces as best it can. How oil introduced at the circumference of the crankcase, in close proximity to the revolving flywheels, can be expected to reach the big end and main bearings, the author cannot see. The fact is that, as a rule, too much oil is supplied to the piston, and the other bearings are left to be lubricated by oil mist, which is not satisfactory for the high bearing pressures that are met with in motorcycle engines. The only salvation of this system was the use of a hand pump to supply the oil to the crankcase, as the rider, by injecting the charge quickly, forced a jet of oil into the crankcase, which did actually souse the big end with lubricant. The hand pump, nevertheless, is open to very serious objections, which are well known to all riders. It makes the lubrication entirely dependent on the vigilance and experience of the driver, the lubrication can never be accurately adjusted to the needs of the engine, and the piston is alternately over-lubricated and starved. Nevertheless, if the system of pure splash lubrication from loose oil in the crankcase is retained, the hand pump is the only suitable means of supplying the oil. Drip feeds, mechanical pumps, or suction systems, which supply the oil at a constant rate in small drops are not suitable, since although they may supply the oil in correct quantities, quite without attention from the driver, they do not supply that bath of lubricant for the big end every few miles which is supplied by the hand pump. Of course, the loose oil splash system is entirely unsuited for use on a high-speed petrol engine, particularly if air cooled, and it is surprising that it has been retained so long. Regulation of the quantity of lubricant supplied to the bearings cannot be obtained, and what oil is supplied is impoverished by heat, and dirtied by particles of carbon long before it reaches the bearing surfaces. In fact, it is impossible, under any conditions, to ensure the supply of a correct amount of either cool or pure oil to the bearings.

One or two engines, particularly in the Vee-twin cylinder class, are provided with drilled crankshafts, and this is a great step forward in the right direction, but unfortunately they still rely on hand pumps and drip feeds for the supply of oil. The drilled crankshaft, if used in conjunction with a mechanical pump, would be reasonably satisfactory, and the design of such a system is so simple a matter that it is to be hoped that its general adoption will not be long delayed. The lubrication system of the engine must undoubtedly be independent of the driver, and it must ensure good oil reaching all bearings in correct quantities. There has been a movement in favour of proportioning the oil supply to the throttle opening as well as to the engine speed, and while this is certainly correct practice, experience with other types of engines has shown it to be an unnecessary refinement which is liable to lead to heavy oil consumption. On engines which have a separate crank throw for each cylinder, such as the horizontally opposed twin and the four-cylinder, very satisfactory lubrication can be obtained by the adoption of the trough system which is so popular on cars, the expense of drilling the crankshaft thus being avoided, and there are one or two engines of this type already on the market which are quite well equipped. An improvement in the lubrication system on most machines is undoubtedly one of the crying needs of the moment. The present crude systems are wasteful in the extreme, and are responsible to a considerable extent for the lack of durability which characterises many engines, as well as for the necessity of frequent decarbonisation, which is such a nuisance to the ordinary motorcyclist.

The author does not propose to enter into a full discussion of the comparative merits of the various types of engines available for use on motorcycles, since the question will be dealt with exhaustively in another paper later in the session. A brief survey of the present position is nevertheless desirable. The outstanding feature of motorcycle practice is undoubtedly the continued survival of the single-cylinder four-stroke engine in English specifications. In the early days of motorcycles, when engines were liable to serious troubles on the road, there was some justification for the use of the simplest possible type, but now that it is possible to produce two- and four-cylinder engines which will not only equal but surpass the average single-cylinder engine on the grounds of reliability and durability, the continued use of the latter is nothing short of amazing. The single-cylinder engine weighs more per brake horse power than any other type; its acceleration is bad; it cannot be balanced at all, and the effect of its uneven production of power on the transmission and frame of the motorcycle on which it is used is exceedingly bad. It is also difficult to silence, and uncomfortable to ride over, and it renders the machine unstable on greasy surfaces. In its larger sizes it is difficult to cool satisfactorily by air, and its one advantage of high thermal efficiency, and consequent low petrol consumption, is offset partly by this cooling difficulty which makes high-compression ratios undesirable, and partly by the fact that the tremendous surging which occurs in the induction pipe makes good carburation exceedingly difficult.

It is true that the single-cylinder machine still finds many supporters among the buying public, but

in the author's opinion this is due solely to the fact that it is still used by some of the largest and most famous firms in the industry. In the very smallest sizes it has been displaced, to a great extent, by the single-cylinder two-stroke engine, largely on account of the extreme simplicity of the latter, and its much more even crank effort. In the 350 c.c. class it has been almost entirely ousted by the horizontally opposed twin-cylinder engine, which has several important advantages, chief among which are its almost perfect balance, its more even crank effort, and its lighter weight. It seems that this type of engine is the most suitable for sizes from 350 c.c. to about 600 c.c. capacity, but above this size its length makes it rather an awkward engine to handle. From 600 c.c. to the maximum of about 1,000 c.c. the small angle Vee twin-cylinder engine is exceedingly popular. It is a vast improvement on the single-cylinder engine, so far as regularity of crank effort is concerned, but it suffers from nearly all the detail faults of the other, and cannot be well balanced, while the unevenness of the intervals between the opening of the inlet valves in the two cylinders does not make for efficiency in the carburetter. The 90 deg. twin-cylinder engine, to which comparatively little attention has been paid during recent years, is even worse from the carburation point of view, but it can be arranged to be in perfect primary balance, which is a great advantage. It is undoubtedly rather difficult to house in the conventional type of frame, but there is little difficulty in designing a special frame to suit it, so that it is likely to be resurrected by some designers. The entire absence of the four-cylinder engine from British manufacturers' specifications for engines of 750 c.c. to 1,000 c.c. is somewhat astonishing, since it possesses many evident advantages. Its balance is excellent, its characteristic crank effort curve is very regular, it can be well cooled, and it allows of the use of a really efficient single lever carburetter. It is quite easily housed in a machine of reasonable wheelbase, it is the lightest of all the types considered, and if properly designed its bearing surfaces can be so large that far greater durability can be obtained than with any of the other motorcycle types. It is often said that the non-appearance of the four-cylinder engine is due to its high cost of manufacture, but the author does not believe that it need cost appreciably more than a small angle Vee twin-cylinder engine of equal capacity, since its general layout gives the designer more opportunities of reducing production costs. Moreover, the absence of the high peak loads which occur with the single and twin-cylinder engine makes possible the use of a lighter and smaller transmission, and greatly reduces the stresses on the frame, so that if extra cost is incurred in the engine, it may easily be recouped by coresponding savings on other parts of the machine.

(To be continued.)

Abbots Foundry Co. Ltd. (10,470). —Private company. Registered in Edinburgh, June 18th. Capital £50,000, £1 shares. Iron and brass founders, enamellers, ironmasters, metal forgers, stove makers, colliery proprietors, engineers, etc. Agreement between (1) James Miller, Son, and Co., ironfounders, Falkirk, A. W. Miller, G. S. Orr, and D. Miller, and (2) Abbots Foundry Co. Ltd. First directors: A. W. Miller, G. S. Orr and D. Miller. Solicitor: G. L. Woodrow, 183, St. Vincent Street, Glasgow.

HEAT APPLIED TO ENGINEERING.

By Prof. W. W. Haldane Gee, B.Sc., M.Sc.Tech.

(*Continued from page 278.*)

Resistance Compensation.

The pyrometers introduced by Bristol have certain special features. Those with base metals have wires of $\frac{1}{16}$ to $\frac{1}{8}$ in. in diameter. They are insulated by winding each wire with asbestos cord and then painting with a mixture of powdered carborundum and a syrupy solution of silicate of soda. This insulation has been found satisfactory to 2,000 deg. Fah. The two wires are twisted together at the hot end and welded, and when necessary the couple is enclosed in a tube of nickel, wrought iron, plumbago, or porcelain. In the case of a burn-out or other injury to the hot end, this part may be renewed by the use of the coupling shown in Fig. 38. The ordinary terminals are connected by twin flexible copper leads to a Weston millivoltmeter (see Fig. 39); the total resistance in the circuit is 10 ohms, so that a relatively strong current flows, and a millivoltmeter of robust construction can be used. The low resistance enables a simple compensating device for change of resistance, due to temperature changes, to be utilised. This

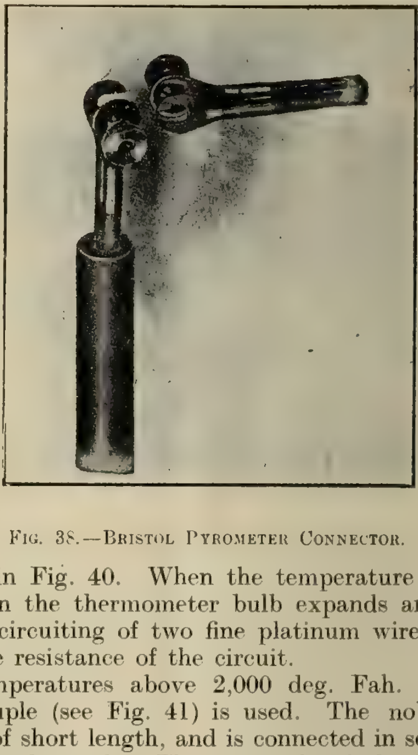

Fig. 38.—Bristol Pyrometer Connector.

is shown in Fig. 40. When the temperature rises the mercury in the thermometer bulb expands and causes the short-circuiting of two fine platinum wires, and so lessens the resistance of the circuit.

For temperatures above 2,000 deg. Fah. the compound couple (see Fig. 41) is used. The noble metal couple is of short length, and is connected in series with a base metal couple. The materials of the latter are selected and the length and cross section so adjusted that the pressure set up by the contact of the base metals with the noble metals neutralise each other.

The further consideration of electrical methods of measuring temperature will be postponed until the production of heat by the use of electrical energy has been discussed.

Electrical Heating.

Heat production by the conversion of electrical energy possesses many advantages over other methods

for obtaining heat. There are no products of combustion; the heat may be produced at any moment at any place by the closing of a switch, and the temperature is easily regulated by changing the resistance in the circuit or by adjusting the voltage of supply. With the cheapening of electrical energy there must come a great extension of electrical heating for a number of scientific, technical, and domestic purposes

Thermal Units.

The amount of heat produced electrically or in other ways is expressed in terms of thermal units, of which three kinds are in use :—

1. *The small calorie*, which is the amount of heat necessary to raise one gram of water through one degree Centigrade.
2. *The large calorie*, or kilocalorie equal, to the amount of heat required to raise a kilogram of water through 1 deg. Cen.
3. *The British thermal unit* represented by the heat which will raise one pound of water through one degree Fahrenheit.

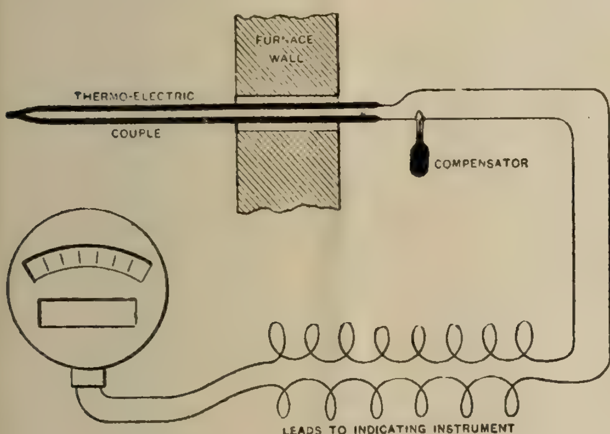

FIG. 39.—BRISTOL PYTER ELECTRICAL CONNECTIONS.

For engineering purposes the small calorie is inconveniently small, so that either the kilocalorie or the British thermal unit is used. It is important to know the relation between the latter units. We have

$$1 \text{ lb.} = 0{\cdot}454 \text{ kilo.}$$
and $$1^\circ \text{ F.} = 5/9^\circ \text{ C.}$$
Hence $$\frac{1 \text{ kilocalorie} \times 9}{5 \times {\cdot}454} = 4 \text{ (nearly) British thermal units.}$$

This simple conversion factor of 4 is sufficiently accurate for most technical purposes. If 453·6 grams be taken as equal to 1 lb., then one British thermal unit = 252 calories.

EXAMPLE.—One cubic foot of coal gas gives, when burnt, 500 British thermal units. Convert this into small and large calories.

ANSWER.—

$$\frac{500}{4} = 125 \text{ large calories, and}$$
$$1{\cdot}25 \times 10^5 \text{ small calories,}$$

or more accurately, $500 \times 252 = 1{\cdot}26 \times 10^5$ small calories.

The Laws of Joule.

In 1840 J. P. Joule experimentally discovered the laws of electric heating. They may be expressed as follows :—

Let a current of C amperes flow through a resistance of R ohms for t seconds and produce H small calories, then

$$C^2 R t = J H \tag{1}$$

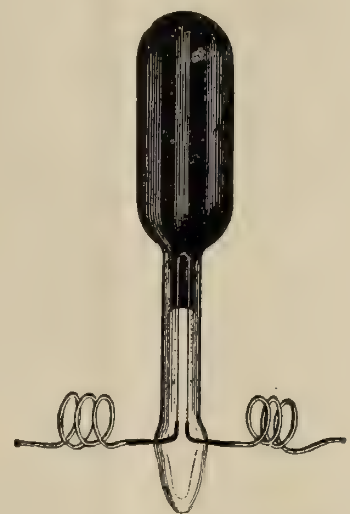

FIG. 40.—BRISTOL COMPENSATOR.

Where J is the mechanical equivalent of heat, whose value is approximately 4·2. Since by Ohm's law C = E/R the above equation may be written :—

$$E C t = J H \tag{2}$$
also $$E^2 t/R = J H \tag{3}$$

The left-hand expression in each of the three equations measures the electrical energy in *joules*. A joule is the power of a *watt* employed for one second, or

$$\begin{aligned} \text{joules} &= \text{watts} \times \text{seconds} \\ &= \text{volts} \times \text{amperes} \times \text{seconds} \\ &= \text{volts} \times \text{coulombs} \\ &= 4{\cdot}2 \times \text{calories.} \end{aligned}$$

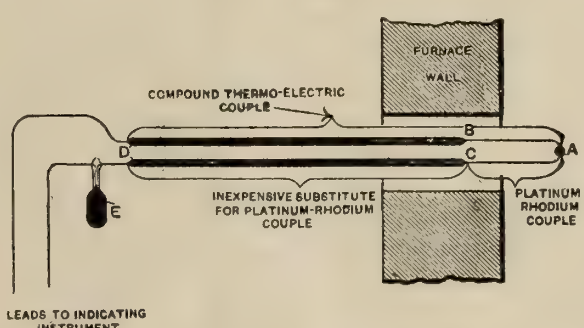

FIG. 41.—BRISTOL HIGH TEMPERATURE PYROMETER.

EXAMPLE 1.—Find the heat produced when 10 amperes pass through a resistance of 42 ohms for an hour.

ANSWER.—

$$\text{Large calories} = \frac{10^2 \times 42 \times 60^2}{4{\cdot}2 \times 1000} = 3600.$$

EXAMPLE 2.—A voltage of 100 is supplied to a constant resistance of five ohms for 30 minutes, find the British thermal units produced.

Answer.—

$$\text{British thermal units} = \frac{100^2 \times 30 \times 60 \times 4}{5 \times 4{\cdot}2 \times 1000} = 3430 \text{ (nearly)}$$

Example 3.—If 20 kilowatts is used for five hours how much heat is produced ?

Answer.—

$$\frac{20 \times 1000 \times 5 \times 60^2}{4{\cdot}2 \times 1000} = 85{,}714 \text{ kilocalories (nearly)}.$$

In commercial use the small unit, the joule, is replaced by the kilowatt-hour or Board of Trade unit of electrical energy. A more convenient name for this unit is the *kelvin*, which, although not officially sanctioned, is frequently used by engineers. It is important to ascertain the thermal value of the kelvin. We have :—

$$1 \text{ kelvin} = 1000 \times 60^2 \text{ joules}$$

and $\frac{1000 \times 60^2 \times 4}{4{\cdot}2 \times 1000} = 3429$ British thermal units.

If a more accurate value of 4·18 of the mechanical equivalent of heat be used, and the British thermal unit be defined as the heat required to raise one lb. of water from 60 deg. to 61 deg. Fah. the above value becomes 3418.

Resistance Materials.

If the material in which the electrical energy is converted into heat is in the form of a wire or rod of uniform cross section its resistance is expressed by the equation :—

$$R = \rho \frac{L}{A}$$

where ρ is the *specific resistance*, or *resistivity* at the temperature of use, L the length and A the cross-section of the conductor. It is convenient to express L in cms., A in square cms. and ρ in microhms. The value of ρ depends on the temperature, and for small temperatures we can write :—

$$\rho^{t} = \rho^{o} (1 + \alpha t)$$

Where ρ_t is the specific resistance at $t°$, and ρ^{o} that at O° C, α being the temperature coefficient.

The selection of a suitable alloy for the purpose of electric heating will depend on the temperature to which it is desired to raise the material. When the required temperature is high the substance must have a high melting point and not oxidise. These requirements are fulfilled by certain nickel alloys, especially those containing chromium. The introduction of these alloys has been of very great service in the manufacture of electric heating appliances, especially electric stoves, ovens, and water heaters.

In the following table the value of ρ and α for a temperature of about 15 deg. Cen. is given for a number of alloys.

Table of Resistance Materials.

Alloy.	ρ Microhms — cm. cube.	α Per cent per 1° C.	Remarks.
Nichrome II. ...	109	0·016	Density = 8·02. 2800° Fah. melting point.
Nichrome	100	0·044	Density = 8·15
Nickel-Chrome ..	93·5	0·013	Density = 8·28.
Concordin	96	0·016	....
Climax	87	0·067	Density = 8·14. A nickel steel.
Vestalin	80·1	0·070	Density = 7·50.
Resista	76·5	0·110	....
Constantan or Eureka.	50·2	0·0005	60 % Cu., 40 % Ni.
Advance	48·9	0·00018	Density = 8·9.
Ferry	47·2	0·0022	Density = 8·99.
Manganin	43	0·0017	Density = 7·3. 84% Cu., 4% Ni., 12% Mm.

Theory of Electric Heating.

The first approximation to the laws relating to the temperature produced by electric heating may be conveniently studied by electrically heating about a yard of nichrome or other wire stretched horizontally in the air between two vertical supports. It should be supplied with a direct current voltage of from 100 to 220 through a resistance which can be varied by steps. An ammeter is placed in the main circuit and a voltmeter used to indicate the pressure at the ends of the wire. It will be necessary to adopt some method for measuring the temperature of the wire. The lower temperatures can be measured by suitable thermo-junctions and the higher temperatures by optical pyrometers.

The wire receives heat electrically and loses it by radiation, convection and conduction. When the heat supplied is equal to that lost, the wire attains a steady temperature. To investigate the conditions it will be assumed that the loss of heat is entirely due to the radiation from the wire. This radiation will depend upon the surface of the wire, the temperature of the wire above the surroundings, and to a constant depending on the nature of the wire. To obtain an approximate law it will be supposed that the Law of Newton can be applied. This law states that the loss of heat is simply proportional to the temperature of the wire above the surrounding temperature, which will be taken as that of the air. We have then :—

$$\frac{C^2 R}{J} = \pi d L e T$$

Where $C^2 R/J$ is the electrical supply of heat per second, d the diameter of the wire, L its length, T the temperature of the wire above the air, and e a constant known as the *emissivity*. Replacing R by ρ L/A then :—

$$\frac{C^2 \rho L}{J A} = \frac{C^2 \rho L}{J \frac{\pi}{4} d^2} = \pi d L e T$$

or

$$C^2 = \left(\frac{\pi^2}{4} \frac{J}{\rho}\right) d^3 e T.$$

If we assume that the wire does not change in specific

resistance then the expression within the brackets is constant. Calling it K then :—

$$C^2 = K\, d^3\, e\, T.$$

For a wire of diameter d_1 heated to the same temperature then the required current C_1 will be—

$$C_1{}^2 = K\, d_1{}^3\, e\, T.$$

Hence :—

$$\frac{C^2}{C_1{}^2} = \frac{d^3}{d_1{}^3}$$

or the squares of the currents will be as the cube of the diameters of the wires.

(To be continued.)

THE WAGE PROBLEM IN INDUSTRY.

By W. L. Hichens

(Chairman of Cammell Laird and Co. Ltd.).

(Continued from page 343.)

But the domination of either, or both, would be a disaster to the community as a whole, just as the present rivalry between the two opposing forces is a disaster. The mistake lies in isolating the interests of all three—capital, labour, the community; in the selfishness, to use a plain term, which causes both capital and labour to organise in their own interest against each other and against the community; in the false ideal which enthrones King Might and banishes Justice. Clearly both capital and labour are as necessary to the corporate existence of a community as are the head and hands to the human body. Each has its separate function to fulfil, and each is entitled to its reward. But both work for a greater whole, and neither may claim to dictate what their reward shall be. The community, through its chosen representatives, should exercise its right to regulate the demands of both and, unless anarchy is to ensue, both must be prepared to accept loyally the verdict of the constituted authority. All wages are a question of relation. What matters is, how much a carpenter, for example, earns in relation to a boilermaker, a school teacher, or a parson; how much of the general wealth a capitalist gets in relation to a man whose only assets are his brains and his hands.

Settlement of Disputes.

The demands, therefore, of the wage-earners in each trade and each industry cannot be settled in isolation from each other, or independently of the claims of capital. For an increase in wages in one trade involves an increase in others, and in time these increases react on capital, which requires a higher rate of interest. While, therefore, the organisations of employers and employed in each industry should be responsible in the first instance for negotiating all wages problems, the Government should exercise the right of reviewing all decisions from the wider standpoint of the general interest, and should regulate both the profits of capital and the wages of labour in order that a due proportion may be observed. Governments exist primarily in order to do justice as between one individual and another, between one section of the community and another. They have surrendered this duty in the past, so far as industry is concerned, owing to the false teachings of political economists, who succeeded in substituting the laws of supply and demand, and of unrestricted competition, for the moral code. But ultimately, all industrial questions, as well as all the other questions affecting human relations, resolve themselves into moral problems, and how far we succeed in solving these questions depends on the degree of moral consciousness to which the community has attained. Failure, therefore, to solve our industrial problems implies a moral failure on our own part, and it is as well to recognise it frankly, and to realise that the most profound and exhaustive research will never find a substitute for the moral code which is the mainspring of all human societies. The words "Seek ye first the Kingdom of God, and all these things shall be added unto you," have become a commonplace of literature, and are probably endorsed in church on Sundays by innumerable congregations as sound doctrine, but inapplicable to the affairs of everyday business life. Once back in the work-a-day world common sense prompts us to murmur :—

> "Ah! take the cash and let the credit go
> Nor heed the rumble of a distant drum."

But is it really common sense ?

Discussion.

Mr. E. W. Mundy (Secretary, Labour Co-partnership Association), in opening the discussion, said he thought the author, in speaking of labour co-partnership, had looked very far ahead to a time when the whole of an industry would be conducted on the lines of labour co-partnership. In attacking that system, the author had done so chiefly by imagining that there was a trust or combine of the whole of a trade, and saying that then there would be likely to be a combination between the capitalist and the employee, who were sharing profits, in order to mulct the consumer. Personally, he did not quite follow that argument, because what was there in that combination between the capitalist and the labourer which would enable them to raise prices? Why should the fact that the capitalist was fighting against the employee, rather than working with him, give him less power of putting up his prices? He failed to see how the workman could affect the power of the employer to raise prices. Co-partnership as practised at the present time had brought about a much better feeling between the employer and the employee. Perhaps one of the best examples he could give was that of the South Metropolitan Gas Company, the Chairman of which, Dr. Carpenter, in a recent speech, emphasised the extremely good relations which had existed between his workmen and himself and the Company during the time of the war, and said that those relations were chiefly due to the co-partnership scheme that existed. He would like to ask the author a question on the earlier part of the paper, where he said that an industry could not be carried on without renewed capital—without putting fresh capital into the business. He took it that every business—at any rate every successful business—put fresh capital in every year, which they called reserves, and every stable business built up reserves for itself: but the author seemed to hint that the only way of getting fresh capital was to obtain it through the individual

savings of shareholders, who were given higher rates of interest than were necessary in order that they might have some money left to reinvest in the business. He would suggest that there was a possible way out of the difficulty, namely, the building up in the business of the unnecessary profits of that business—by "unnecessary profits" he meant those profits which need not be distributed in order to attract fresh capital from outside. The author also stated that if the rates of interest were lowered—and he took it the author meant the rates of interest over a wide area—money would no longer be invested. He thought that was a very serious proposition at the present moment, because most people recognised that real wages had to be raised in industry above their pre-war level. Now if wages, prices, and interest on capital were all raised, the position would be the same as it was before. It seemed to him that one of those three would have to remain where it was, and that capital would have to be content not to double its rates of interest if prices and wages were doubled, which meant that the interest on capital would be reduced if real values were considered. He did not think that would prevent capital from being put into an industry, because the rate of interest would be reduced over the whole area of industry, and people would still put their capital into the business from which they obtained the greatest security and the highest rate of interest as compared with other businesses. Of course, if people could get a better rate of interest and better security abroad, he supposed they would invest their capital there, and then the only thing for a company in this country to do would be to save up in its own business, and not trust to fresh money being put in by individual people.

Mr. Neville Priestley, after congratulating the author on his admirable paper, said he wished to challenge him on two points. The author stated that co-partnership would be impossible on a large scale because there would be industries where one factory was doing well and labour therefore received its share of large profits, and where another factory was doing badly and labour received only small profits. That state of affairs, the author contended, would create discontent amongst the employees of the factory that was doing badly, and they would demand something to put them on an equal footing with the employees of the factory that was doing well. That was true to a certain extent, but it brought out one very important consideration which this country had largely lost sight of, namely, that the people of this country were too much attached to "one-man businesses," and were too much inclined to bolster up weak concerns, instead of allowing them to die out and the larger concerns to develop. If prices were to be reduced it was obvious that the more various businesses were concentrated, and their production increased, the larger would be the output of the unit, the smaller would be the profit required on each unit to pay a return, and therefore the larger would be the general prosperity of the nation. A great deal of the trouble in this country was caused by maintaining moribund or semi-moribund businesses. The second point he wished to refer to was the author's contention that if labour and capital combined in a great scheme of co-partnership the consumer would suffer. He challenged that statement, because at the present moment there were in this and other countries large combinations of capital, that was to say, combinations of those who were controlling industries. They controlled the price that was charged to the consumer, and, if they did not oppress the country—he did not say that they had not done so, but that did not affect the argument—the position would be no different if there was a further combination between capital and labour in the nature of co-partnership. He was in entire agreement with the author that the Government ought not to manage businesses themselves. They ought to be the arbiter between the three parties—labour, capital, and the consumer; and the Government ought to step in and insist that, while capital was paid its full price and labour was paid its full price, the consumer was not exploited by either. There was another way out of the difficulty, *i.e.*, to divide the profits not between capital and labour, but between capital and labour and the consumer, which was the method adopted by the South Metropolitan Gas Co. That Company could not charge the public a higher rate without reducing the interst on their own capital or the bonus they paid to their employees, and if they wanted to pay a higher rate of interest to the shareholder or a bigger bonus to the employee they had to reduce the rate to the consumer, so that the benefit was shared by all three parties. That principle could not be applied to ordinary trade, because it was impossible to get hold of the consumer after the goods had once left the factory, but the result could be obtained by carrying out the method that had been introduced during the war and that bore the very obnoxious name of "excess profits tax." Whatever profits were made over and above the amount necessary to pay labour its wages, and capital a reasonable interest on the money invested, should be divided between the labourer and the capitalist and the consumer—that was to say, the State on behalf of the consumer—and the consumer would reap the benefit by having his taxation generally reduced. While there were difficulties in the way of the general adoption of co-partnership, he was quite sure that, until the workman and the employer could be brought on to the same basis—and co-partnership did not mean only division of money but also division of responsibility and mutual interest in the general management of a concern—the claims of labour would continue to be as irresponsible as they were now and capital would never be on friendly terms with labour, but each would be trying to snatch something from the other or to keep back something from the other, and the conditions would always be as unsatisfactory as they were to-day.

(To be continued.)

French Views on Dealing with the Germans.—"Should we do business with the Germans?" inquires a correspondent of *l'Electricité*. "Why not? Our Allies the English and Americans have not waited for the signing of Peace to realise some handsome profits." What we have to do, continues this correspondent, is to exclude the German traveller, so that Germany may not compete with the national industry in our market. This, however, alas, is in vain, for Boche material can be procured in France in good condition, so a firm informed him when applying for prices of electric apparatus. A Zurich correspondent of our contemporary reaffirms the first statement. "The English and Americans have already, at the present moment, begun to deal with the Germans on a great scale." Without presuming to prejudge the question, he adds that it is one which French economists and manufacturers should re-examine in all its complex bearings before coming to a final decision.

SOME THERMAL RELATIONS OF COAL, ELECTRICITY, AND GAS, FROM A NATIONAL STANDPOINT.

By Ed. C. de Secundo, Assoc.M.Inst.C.E., M.Inst.Mech.E., M.Inst.E.E.

(*Concluded from page 355.*)

The Value of Tar Oils.

Gas, however, is not the only product of the carbonisation of coal which is directly employable as the working fluid in the production of power. One of the distillates of coal tar—creosote oil—has a calorific value of about 16,500 B.Th.U. per pound, and Professor F. W. Burstall (Professor of Engineering at the University of Birmingham) has recently carried out a series of trials upon one of Messrs. Crossley Bros. new type "cold starting" oil engines specially designed for working with residual and tar oils, the results of which are very interesting and instructive. The consumption of creosote oil per b.h.p. per hour (including a small quantity of kerosene used for ignition purposes) was 0·534 lb.; 0·475 lb. and 0·488 lb. at 146 b.h.p. (25 per cent overload), 102 b.h.p. and 67 b.h.p. respectively, the corresponding heat expenditure being 8,420, 7,750, and 8,140 B.Th.U. and the thermal efficiencies (calculated on the b.h.p.) 30·22 per cent, 32·84 per cent, and 31·26 per cent respectively. Professor Burstall draws attention to unavoidable circumstances which, he considers, somewhat reduced the attainable thermal efficiency with tar oil; but taking the thermal efficiency at 32·84 per cent, the heat expenditure would work out at under 12,000 B.Th.U. per kilowatt-hour received by the consumer, allowing a commercial efficiency of 97 per cent in the direct connected electric generator and 10 per cent transmission losses to customer.

This figure is worth bearing in mind to-day when the claims made by the advocates of "super electric stations" are kept so prominently before us. The heat expenditure per kilowatt hour metered out from the Connor's Creek power house is given by Mr. Alex. Dow, president of the Detroit Edison Company, in an address delivered by him to the American Electrotechnical Society last year, as 19,700 B.Th.U. and 20,040 B.Th.U. for the years 1916 and 1917 respectively. Allowing 10 per cent for transmission losses to customer, the average works out to about 22,000 B.Th.U. per kilowatt-hour received by the customer, and is the lowest figure which, so far as I am aware, has been published by any electric generating steam-driven plant.

In the course of one of his Cantor Lectures recently delivered before the Royal Society of Arts, Professor Bone said that he had been authorised to state that in one large steam-driven electric station in England the heat expenditure per kilowatt-hour generated did not exceed 20,000 B.Th.U., which would correspond to about 22,222 B.Th.U. per kilowatt-hour received by the customer. In a paper read before the Royal Society of Arts on 7th May this year Mr. Highfield stated that "with present methods, about 18 per cent of the heat energy of the fuel can be converted into electrical energy." This would correspond to about 21,000 B.Th.U. per kilowatt-hour received by the customer. No doubt a somewhat lower figure may ultimately be attained by steam-driven plants, for boiler pressures of 500 lb. per sq. in. and upwards and very high superheats are now seriously contemplated. No doubt, also, the makers of internal-combustion engines will make further progress.

In comparing prime movers, many other considerations besides thermal efficiency have, of course, to be taken into account—capital expenditure on plant, for instance. But you can make money, whereas you cannot make coal, and whether the word "conservation" be taken to mean "quantitative economy" in the use of our coal or the efficient utilisation of the coal, Professor Burstall's results with a distillate from a by-product in the carbonisation of coal afford, at least, food for serious reflection.

A Comparison.

The following table sets forth in Column II. the quantities of coal which are completely destroyed (*i.e.*, the real draft on our coal resources) per million B.Th.U. of useful heating effect in warming our houses under the methods set forth in Column I. The calorific value of coal is taken at 13,000 B.Th.U. per pound.

I.	II.	III.	IV.
Source of heat.	Weight of coal destroyed per million effective B.Th.U.	Per cent of heat-value of quantities in Col. II. utilised.	Per cent lost.
	Lb.		
A.—Burning of gas (500 B.Th.U. per cubic foot) in best modern gas fire (75 per cent of heat-value of gas consumed radiated or conducted into room), credit being given for 70 per cent of the calorific value of the combustible secondary products..	145	53	47
B.—Burning of coal (13,000 B.Th.U. per pound) in—			
(i.) Central heating apparatus (say, 80 per cent of heat of combustion conducted)	96	80	20
(ii.) Best type of modern fireplace (say, 30 per cent radiated)	256	30	70
(iii.) Average in domestic heating (including kitchen ranges), estimated	427	18	82
C.—Dissipation of electrical energy. Efficiency of apparatus taken as 100 per cent (excluding cooking apparatus)			
(i.) Best result in practice by steam-driven electric generating plant which, so far as I know, has been published (transmission loss from power-house to customer taken, all round, at 10 per cent)	472	$16\frac{3}{4}$	$83\frac{1}{4}$
(ii.) Probable average in central station practice (large and small) throughout kingdom with good coal	1,173	$6\frac{1}{2}$	$93\frac{1}{2}$

If the actual average performance of heating appliances, including cooking apparatus, could be ascertained, the weight of coal destroyed per 1,000,000 B.Th.U. usefully employed by the average householder would probably be found to be about 170 lb. in the case of gas heating (credit being given for 70 per cent of the

heat value of the combustible products concomitantly produced); about 400 lb. in the case of coal burned in open grates and kitchen ranges, and about 2,000 lb. in the case of electric heating (on the basis of average coal consumption in central station practice throughout the kingdom per kilowatt-hour received by the customer), corresponding to heat wastes of about 55 per cent, 80 per cent, and 95 per cent respectively.

The Importance of Fertilisers.

As *The Gas World* is, presumably, read by many other people besides gas engineers, it may be well to point out that the figures tabulated in sections A and B of the table do not by any means represent the complete case from the point of view from which this article has been written. So far as the figures themselves are concerned, it would appear that if central heating apparatus were adopted throughout the kingdom the net draft upon our coal resources for domestic heating could be reduced to something under a quarter of the present consumption, which is, indeed, what Mr. A. H. Barker contends, and, arithmetically this contention is unassailable. It is, however, equally unassailable that the importance of our being kept alive must take precedence of the importance of our being kept warm; also that in order to keep alive we must eat. Now, in the foregoing lines we have spoken only of the combustible secondary products of the distillation of coal in the manufacture of gas. There is, however one non-combustible secondary product—namely sulphate of ammonium—which, on account of its relatively high nitrogen content, is a very efficient fertiliser. At the average rate of increase of the population in Great Britain during the last fifty years, the number of people who will have to be fed in one hundred and fifty years' time is calculable with a fair degree of accuracy, and this subject is one among many others that is giving economists very great concern. It is not impossible that in the near future, historically speaking, the production of a cheap fertiliser like sulphate of ammonium may become a governing factor in national economics. For the purposes of the construction of the above table coal tar has been treated as a fuel, but—as has been sufficiently exemplified during the recent war—the distillates of coal tar may, under certain conditions, become of immensely greater importance than the steam-raising power of coal tar.

Looking at the matter from a broad point of view, it is not improbable that the day will come when, in self-defence, we may have to carbonise all the coal we raise, except that which, for political reasons, is permitted to be exported, and that which for other reasons may unavoidably have to be consumed in steam generating plant for the production of power.

(*Concluded.*)

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Letters to the Editor.

THE PRESSING NEED OF PREVENTING BRIBERY.

To the Editors of "The Industrial Engineer."

SIRS,—I have become president of the Bribery and Secret-Commissions Prevention League (Incorporated), in succession to the late Sir Edward Fry, and I am convinced that the organisation is a live one and very much needed at the present time. That I am not alone in this opinion is shown by the fact that nearly 350 new members have joined since the beginning of last year—of late at the rate of almost one a day. But it must be obvious that to exert a widespread influence in preventing bribery which is so prevalent, the membership of the League should be much larger than it is—on the ground of quality there is nothing to complain of—for in educating public opinion it is the big battalions that count. I should like to appeal, therefore, with your kind permission, to all who prize clean trading and are jealous of our national reputation for honesty, never more needed than now, to suport the League by becoming members. The subscription is only two guineas for a company or firm, or one guinea for an individual. The Secretary of the League (9, Queen Street Place, London, E.C. 4) will be glad to send forms and any further particulars.—Yours, etc.,

LAMBOURNE.

Publications.

Grits and Grinds for June (the house journal of the Morton Company, Worcester, Mass., U.S.A.) opens this month with an interesting article on grinding manganese steel castings, by R. M. Johnson. Manganese steel containing 10 to 14 per cent manganese was originated by Robert A. Hadfield, of Sheffield, England, in 1886. This alloy is very brittle, so much so that it cannot be machined or drilled. It is difficult to cast, as all holes must be cored in the casting, and due to its enormous shrinkage, five-sixteenths inch per foot, no intricate shapes can be made. All finishing therefore must be done by the use of grinding wheels or abrasive grain. A useful description of the process is given. An illustrated article is also given on the rapid turn out of housings and pistons. The Morton grinding machine is capable of turning out 60 housings in 10 hours and 500 pistons in nine hours.

The June issue of **The Boys' and Industrial Welfare Journal** (published by the Industrial Welfare Society) contains some most interesting and educative matter. There is an alphabetical list of the officers and members of the Society given showing the towns from which they come. The success of this journal is very obvious, and in consequence of the increasing demand for it the following small charges, including postage, have had to be made: To firm's members of the Society, 1d. per copy; to firm's hon. members and hon. associates, 2d. per copy.

The catalogues and brochures of to-day are far in advance of those we were formerly used to, and as regards information, they represent trade text-books of value. In printing and general make-up they compare favourably with the best that is turned out by the printer. An example of such a catalogue is that issued by **Messrs. Greene, Tweed and Co.,** of New York, the manufacturers of Palmetto Packing. The British agents of this packing are Messrs. W. F. Johnson and Co., 113, Clerkenwell Road, London, E.C. A useful telegraph code is included. All types of packing made by the firm are described, and the illustrations are unique. We would advise all users to obtain a copy from the agents.

"**The Electrician Tables of Electricity Undertakings**" are now published separately in one cover annually in May. Full data of the various suply undertakings are given, and the volume is of considerable value as a reference medium. The price is 5s. net, and it is published by Benn Bros. Ltd., "The Electrician" Offices, 8, Bouverie Street, London, E.C. 4.

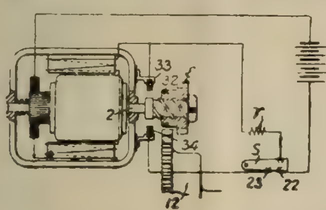
Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

ENGINE TURNING-GEAR.

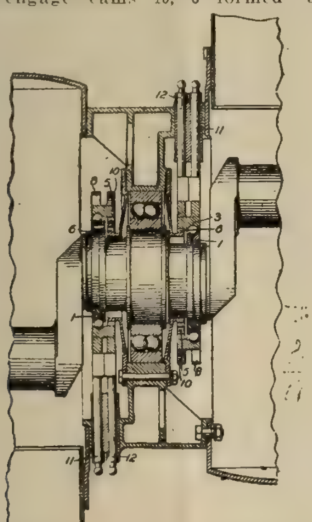
120,312.—A. E. WHITE, 88, Chancery Lane, London.—Feb. 1st, 1918.—In electric turning-gear, an internally-threaded pinion 8 engages a screw-thread on the armature shaft 2 of a motor, and is brought into initial engagement with the engine fly-wheel 12 by axial movement of the armature; when the pinion is brought



fully into mesh by the action of the screw-thread, a resistance r in series with the motor is cut out by a copper ring 32 on the pinion, which engages brushes 33, 34. The switch S is then moved to engage only the contacts 22, 23, so that when the engine starts and the pinion 8 is returned automatically to the position shown, the motor circuit is completely broken.

INTERNAL-COMBUSTION ENGINES.

120,285.—DAIMLER CO., A. E. BERRIMAN, and J. DIXON, Daimler Works, Coventry.—Dec. 3rd, 1917.—The inlet and exhaust valves of a radial-cylinder engine are actuated by valve-rods 12, 11 respectively, which engage cams 10, 8 formed upon a ring 3

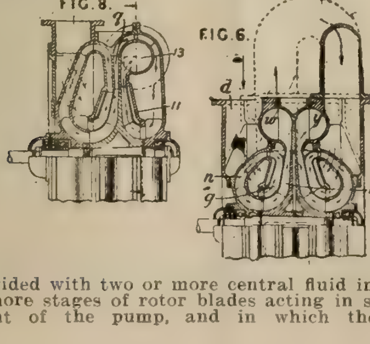


rotating upon an eccentric 1 and having internal teeth 5 gearing with a toothed wheel 6 mounted concentrically upon the crankshaft. As shown, the engine has two sets of cylinders arranged in parallel planes, a different set of cams serving to actuate the valves of the two sets of cylinders.

CENTRIFUGAL PUMPS.

120,401.—W. J. FRAME, 1, Meadway Court, Golders Green, London.—Sept. 3rd, 1917.—In a centrifugal multi-stage pump having

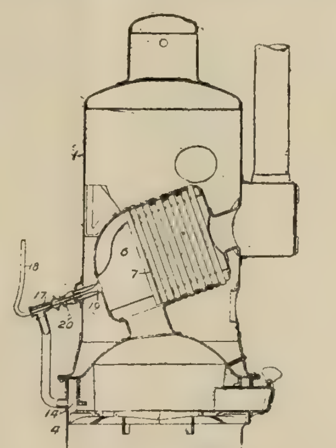
FIG. 8. FIG. 6.



a rotor provided with two or more central fluid inlet eyes leading to two or more stages of rotor blades acting in series within one compartment of the pump, and in which the fluid passing through any one stage of rotor blades does not cross the path of the fluid passing through any other stage of blades within the rotor, the fluid in passing one of the central eyes of one of the rotor stages, crosses the path of the fluid passing to another central inlet eye of the rotor, or to the discharge. Fig. 6 shows a four-stage pump having two impellers, each with two stages, the discharge from one stage of each propeller being axial, and from the other radial. The fluid from the inlet *d* passes through openings in the inward flow guide passages *n* to the suction eye of the first stage *g*. In passing along the passages *n* to the second stage *h* it crosses the first inlet path. From the second stage it passes by the conduit *w* to the third and fourth stages which are similar to the first two stages. The final discharge 13 may be formed between the diffuser *q* from the last stage but one and the inlet to the last stage 11, as shown in Fig. 8, which refers to a three-stage pump, having all the discharges from the impeller radial. Several modified combinations of impellers are described and shown.

STEAM-GENERATORS.

120,350.—H. HORIUCHI, 194, Ryuko Kosho, Taihoku, Taiwan, Japan.—May 17th, 1918.—In a vertical cylindrical boiler having an inclined cylindrical combustion chamber 6 fitted with water-tubes 7 slightly inclined to the axis of the boiler, the shell 1 is inclined outwardly at its bottom and is removably mounted

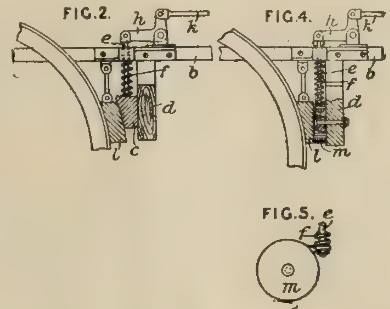


on the furnace casing 4, the furnace being surrounded by an air-heating chamber 14, from which the air supply to the combustion chamber is drawn by an injector 17 operated by steam supplied through a pipe 18. The mouth 19 of the injector outlet-nozzle is flattened. The nozzle may be rotated by a handle 20 so that a jet of steam may be directed upon the water-tubes for cleaning purposes.

BRAKES.

120,413.—R. C. PESSELL, 15, Chestnut Avenue, West Southborne, Hampshire.—April 9th, 1918.—Relates to brakes of the kind in which a wedged-shaped brake block is forced between the wheel and a thrust-plate or block or in which the brake block is forced against the wheel by a wedge block. As shown in Fig. 2, a wedge block *c* is adapted to be thrust between the brake block *l* and a fixed plate or member *d* by a spring *i*. The block

FIG. 2. FIG. 4. FIG. 5.

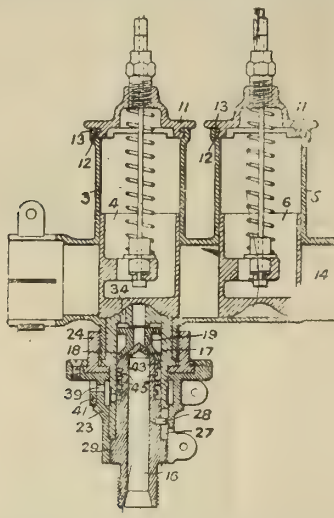


c can be raised to release the brake by the connections *e*, *h*, *k*. The arrangement may be used as a safety brake controlled by the driver's seat as described in Specification 107,458. The spring may be arranged between the bell crank *h* and the member *b* so as to disengage the brake. The block *c* itself may constitute the brake block, the block *l* being dispensed with in this case. Figs. 4 and 5 show a cam-faced disc *m* which, when partly rotated, applies the brake block to the wheel.

INTERNAL-COMBUSTION ENGINES.

120,429.—R. MOORE, 90, Central Avenue, and P. P. PARSONS, 49, Leicester Road, both in Wigston Magna, Leicester, and A. V. STAINTON, Showell Green Lane, Sparkhill, Birmingham.—Nov. 7th, 1917.—The fuel nozzle 16 of a floatless spray carburettor has spraying orifices 18 formed in a conical end 17 which forms a seating for a hollow valve 19 which may be lifted entirely by suction transmitted through holes 34, or partly by suction and partly mechanically from the throttle valve 4, or entirely

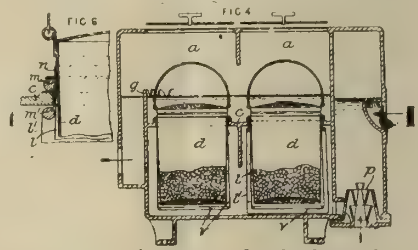
mechanically. The upper end of the valve 19 may have a plane flange as shown, or a conical flange similar to that which rests on the nozzle. The double conical flange facilitates assembling, and provides for interchange of the flanges in case of wear. The nozzle is adjustable axially to regulate the lift of the valve 19 by being screwed at 29 into a rotatable sleeve 23 and itself prevented from rotation by a pin 28 and a slot 27. The sleeve 23 rotates over a flanged nut 24, by unscrewing which the nozzle and valve may be removed as a unit. Air, to mix with the fuel as it issues from the orifices 18, may be admitted through holes 39 adjustable by a ring 41 to pass over



baffles 45 and through holes or notches 43 in the conical head of the nozzle. This air will also pick up fuel that has fallen on to the baffles. The valve may, moreover, be closed when the carburettor is inverted, *e.g.*, on aeroplanes, by a weighted arm which is normally inoperative. The main air supply enters the carburettor at 14 and is controlled by a valve 6. Both valves 6, 4 are spring-loaded and actuated by Bowden wires and the covers 11 of the casing 3, 5 of the valves are secured by segmental lugs 12 which are dropped into grooves in and, after rotation, secured by flanges 13. According to the Provisional Specification. the nozzle housing may be adjusted instead of the nozzle and from a distance by a Bowden wire, and a pilot port may be provided to pass air over the nozzle at starting.

FILTERS.

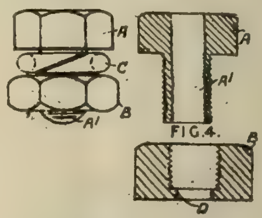
120,442.—D. B. MORISON, Hartlepool Engine Works, Hartlepool.—Nov. 9th, 1917.—Apparatus for filtering boiler feer water, such as that described in Specification 17,638/11, is provided with filters of the type comprising a perforated vessel containing filtering material and enveloped in a bag of fine wire gauze or fabric. In the arrangement shown in Fig. 4, buckets *d*, *d* containing filtering materials are supported by flanges in holes in a horizontal partition *c* in a tank *a* into which water to be



treated passes over a weir *g* at a level above that of the tops of the buckets *d*. The buckets *d* are enveloped in bags *l*, the edges of which enclose rings *m* of rope or the like, Fig. 6, which are held between the partition *c* and the flanges *n* supporting the buckets, or the edge of the bag may be wrapped over the flange *n* and secured by cords. Two bags *l*, *l*1 may be used separated by a rope ring *m*1. Metal rings *v* may be placed in the bags to cause them to hang correctly. The water on leaving the tank *a* may be heated by steam from a nozzle *p*.

LOCKING NUTS.

120,500.—J. TOMBS, 76, Manchester Road, Poplar, London.—Feb. 21st 1918.—A nut A has a threaded extension A1 to receive a second nut B, the face of which is toothed to bite into the work.



A coiled spring C is placed between the two nuts. After both nuts have been screwed down, the nut A is turned back slightly, causing a lock by differential action of the threads. As shown in Fig. 4, the nut B is threaded also at D to engage the bolt.

INDEX TO ADVERTISERS.

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THE

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CONTENTS.

EDITORIAL.

NATIONAL PUBLICITY.

It has always been surprising that the largest of all publishers—the State—should have been so reticent as to its literature. Like the law with which every man is supposed to be acquainted, and no man in a general sense is acquainted; ignorance being no excuse and the legal fraternity being pretty numerous—the average citizen is supposed to know of State publications because they are national.

There is clear room for a new spirit of official adventure in the realm indicated, and since during the war propaganda was undertaken and the art of advertising enlisted in the service of patriotism; making official publications more widely known should now present no novelty to the official mind. No one wishes the State to turn hawker, but certainly greater and more continuous publicity is desirable in the public interest. There has been official enterprise enough to set up a retail shop or bureau where such publications can be purchased and where some of the most recent get a window display, but there seems to be no complete catalogue to the available material, and one is certainly needed. Numerous departments issue reports without reference to public convenience, and tracking these down is rather unnecessary hard labour; in some instances the bureau already mentioned cannot supply, the purchaser is told to apply direct, although the publication in question was neither confidential nor priced. In another instance a copy of regulations which affect an entire industry was desired; the publication is a mine of information upon its subject, and particulars sufficient to identify were given, the purchaser had to wait a week, and apparently there was great difficulty in supply. A day should be ample in any event.

The one exception, and it is notable, is the publication known as the Technical Supplement to the review of the Foreign Press, which deserves all praise, but is apart from the question of the national publications discussed.

Unless the enquirer is aware of precise title, numeral and complete particulars, it is a hopeless quest to search out the public material on a given subject, and such a state of affairs demands rectification.

There should be some central location where all such material should be on file for inspection, in addition to the opportunity for purchase; present methods seem detrimental to the public purse, for apart from the desirability of circulation in the quarters most concerned, the larger the quantity, the less the cost per each.

It would seem only commonsense to notify publication by means of the general and industrial press; such provision might be statutory space, or paid advertisement, and every bookseller knows that open access to his stock is a necessary incentive to trade. It was recently proposed to extend the propaganda undertaken by the War Aims Committee into the realm of more debatable affairs, but the project was hastily dropped the day after its notification in the newspaper press. Clearly, the official mind does not discriminate between publicity and propaganda, and there have been several instances lately where, by preliminary announcement and other means, an attempt has been made to direct public opinion into a particular channel before the appearance of a particular official publication. Such manipulation of public opinion is contrary to all national traditions of freedom, and is a peculiarly dangerous project; at all events, such prepared press material and the scheme

generally was dropped like a live coal within 24 hours of its notification.

The general public and industry in general are rather tired of being spoon-fed with predigested material, and restoration of freedom from all restraint is required at the earliest date.

The interest of the engineer in the subject of adequate publicity in the case of official publications is not small; many of them are technical either in a direct sense or affect him very closely. The authoritative nature of such material lends it an added value, and he can safely be left to draw his own conclusions from pamphlet and report without the intervention of an official guide.

On more than one recent occasion a digest and review of an emergent pamphlet has appeared in the daily press; from the identity of the notices and the fact that the said publication was unprocurable on the same day it is evident that such notice was inspired. It is not contended this was done to destroy adverse criticism, but in one notable instance the publication can be riddled by those with expert knowledge, and the effect of the preliminary announcement gave the industrial press concerned small opportunity to call attention to deficiencies and omissions.

It is believed that propaganda of this type is now to be dropped, but genuine publicity is very desirable. There is accumulating a vast mass of material upon industrial subjects of recent date. There is also much first-class material obtained at very great cost to the taxpayer buried from sight. There is, for one example, a 600-page pre-war Blue Book dealing with the relations of management and labour of greater interest than ever at this present time, yet it is not consulted because it is virtually unknown. Further than this, Colonial Governments also issue tractates and treatises on subjects peculiar to themselves, in some instances of much wider value; giving, as they do, the results of original research and discovery, of value to manufacturer and the student of material or opportunity.

The wonderful publicity work done by the state departments in the United States is perhaps better known because more rationally dealt with by the authorities there.

All such material should be on file for reference, housed separately, catalogued and indexed for those interested.

It was Solomon who asserted that there was no end to the making of books. The activities of the modern State take many forms, and it is often deplored that gross ignorance prevails which causes vast trouble. There is a mass of accredited investigation upon all kinds of interesting topics entombed owing to want of official publicity; to make it generally available is not propaganda to which anyone can object, it is a counsel of sense so obvious that it is curious to point out its lack. Moreover, it is the clear right of the humblest citizen that he should, if he desires, share in the benefit and also in the cost. There seems small reason why any serious financial loss should be incurred.

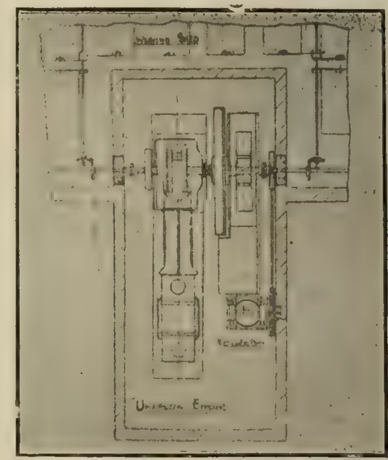
We are notified that Mr. G. W. Cosby, the Northern District Representative of The Westinghouse Brake Co. Ltd. for the sale of Westinghouse-Morse "rocker joint" chains, has now been demobilised, and has re-opened his offices at Standard Buildings, City Square, Leeds—the same address as before the war—and any enquiries received by him will be promptly attended to.

THE UNAFLOW STEAM ENGINE.

By D. H. Yates.

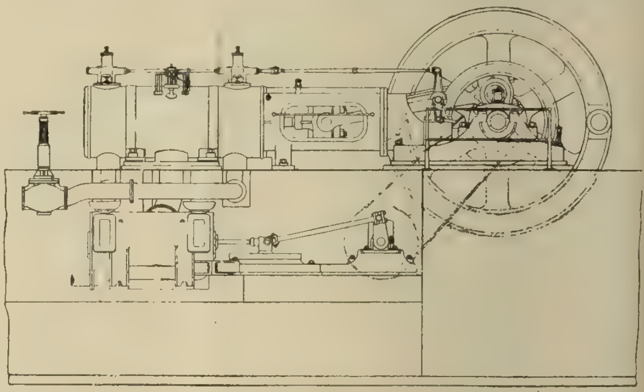
(*Concluded from page 368.*)

The advantage claimed under item (9) is illustrated by Fig. 27, which shows an arrangement of

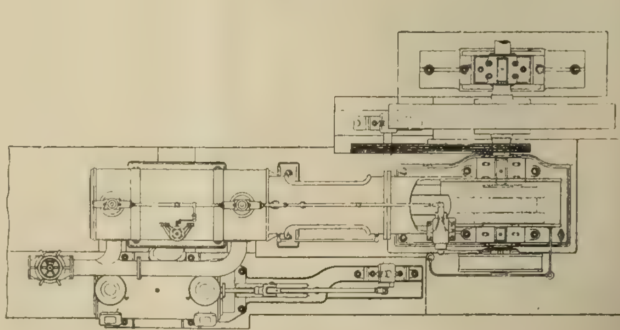


Unaflow Steam Engine.—Fig. 27.

direct-coupled drive for a weaving shed driven by a Unaflow engine. The overall economy of this type



Elevation.



Plan.

Unaflow Steam Engine.—Fig. 31.

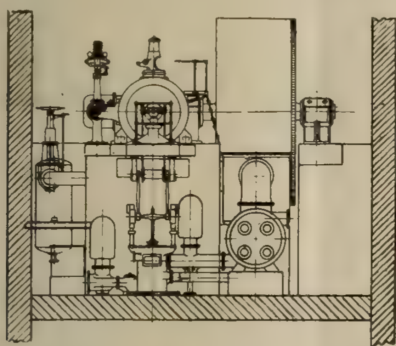
of drive is apparent, and it has an advantage over a compound engine with rope drive of from 5 per cent to 7 per cent, this saving being continuous.

As regards item (12) this is apparent without figures.

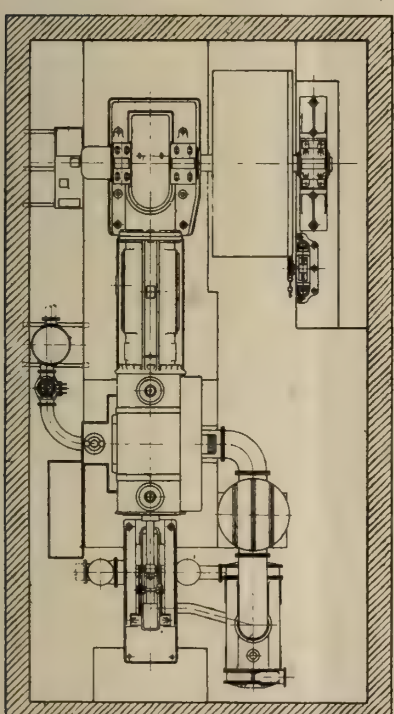
The claims under items (13) and (14) are demonstrated by Figs. 28, 29, and 30, which illustrate the relative space occupied by various types of steam engines, the advantage resting with the Unaflow engine, Fig. 28.

General Remarks.

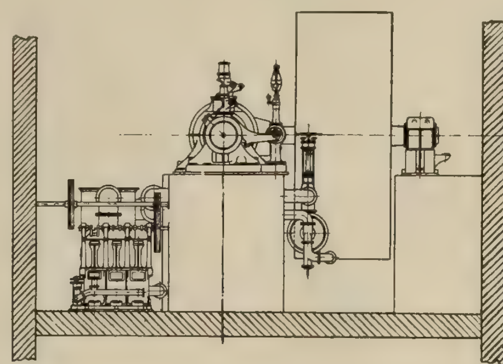
The Unaflow engine is made for driving all classes of mills, rolling mills, air compressors, and locomotives. It is also used as a portable engine, winding engine, pumping engine, marine engine, steam extraction engine, and for driving stamps and presses. There is probably no single instance where it could not be used in place of a counterflow engine; all that is required is perhaps a special arrangement of the valve gear and attention to the compression under different circumstances. Some builders have a central exhaust valve to enable the compression to be carried on over a shorter period than 90 per cent of the stroke, but it is doubtful if anything is gained by this means. It is not essential that the Stumpf valve gear be used, and many makers adopt their own type of steam valve and gear. Perhaps the next two diagrams, Figs. 31 and 32, will be interesting as illustrating the first Unaflow engine made in this country, which was referred to at the commencement of the paper. It is built for 500 I.H.P. and was installed in 1910. The steam consumption test result worked out at 11.51 lbs. per indicated horse power per hour, using saturated steam at 178 lbs. per square inch, with the engine developing 455 I.H.P., and it was this result which encouraged the makers to persevere with the Unaflow engine.



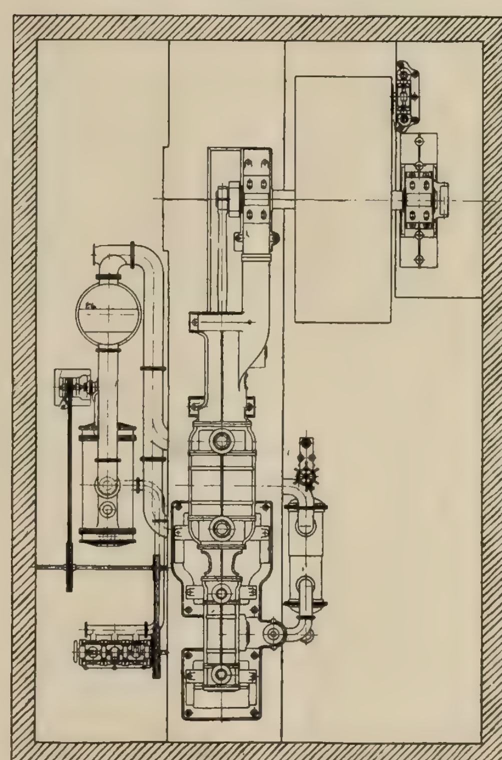
— Horizontal Unaflow Steam Engine. 1400 I.H.P. —



Unaflow Steam Engine.—Fig. 28.



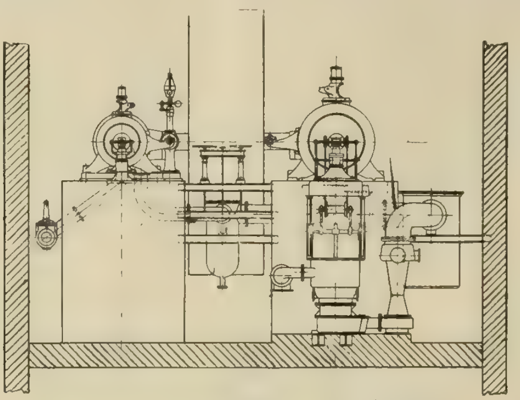
— Horizontal Tandem Steam Engine. 1200 I.H.P. —



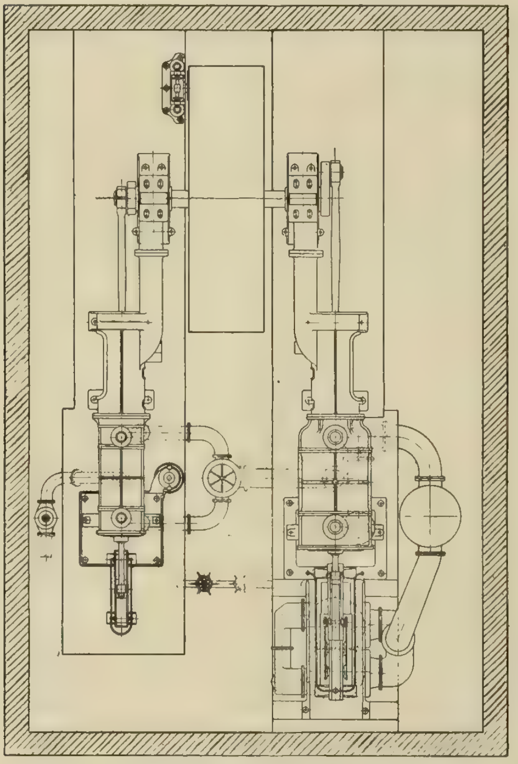
Unaflow Steam Engine.—Fig. 29.

Up to the present time the largest size of a single steam engine unit of the counterflow type which has been made is much larger than any single unit of the Unaflow type. The largest of the latter yet

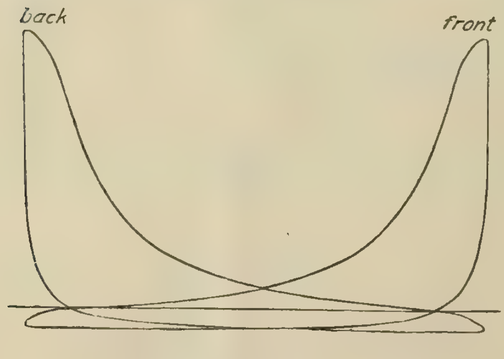
made in this country is one of 1,400 I.H.P., but there is one of 4,000 I.H.P. working on the Continent, made by a Continental firm. As experience



— Horizontal Cross Compound Steam Engine. 1400 I.H.P. —



Unaflow Steam Engine.—Fig. 30.



Unaflow Steam Engine.—Fig. 32.

is gained with the larger units, no doubt the latter size will be surpassed, and eventually we may have Unaflow engines equal in power to the largest counterflow engines, but this is doubtful, as the steam turbine, on account of the smaller space occupied, power for power, will probably be favoured for extremely large units for some time to come. In conclusion, it is safe to say that the Unaflow engine is without doubt the most economical and efficient steam engine on the market, sufficient proof of this statement being abundant by the fact that more engine builders are beginning to manufacture this type as its advantages are realised.

(*Concluded.*)

MOTORCYCLE DESIGN.

By D. S. Heather, B.Sc.

(*Continued from page 392.*)

Clutches.

There are several machines which at the present time are fitted with quite excellent clutches of the dry plate type, utilising either cork inserts or some woven friction material as the driving surface. This is undoubtedly the most satisfactory type of clutch available, since it is sweet in action, capable of a considerable amount of slipping without overheating, and durable in use. A specially woven friction material is preferable to cork inserts, as the latter are apt to hammer loose in the plates which carry them, and finally get cut in half, and become unserviceable. This dry plate type of clutch also has the advantage that it requires no lubrication, as long as the ball bearings are kept packed with grease. The multiplate clutch with steel and phosphor bronze plates is not so satisfactory, since although it allows of sweet engagement if properly lubricated, it usually suffers from dragging when disengaged. There are some machines on the market fitted with clutches of this type, in which the brake has always to be kept hard on when the clutch is disengaged with the engine running. Moreover, if lubrication be neglected at all, the clutch becomes very fierce and may be seriously damaged. The expanding ring clutch as used on machines fitted with change-speed gears of the selective chain type is not altogether a desirable proposition, since it requires lubrication, is somewhat inaccessible and awkward to adjust, imposes heavy end thrusts which cannot very well be taken up in the clutch itself, and also puts heavy bursting stresses on the clutch drums, which necessitates the use of metal of comparatively heavy section for these parts. It is, however, peculiarly suitable for use with selective chain gears, and as long as these are used it is likely to find a place in the specification.

There are some clutches which, while being well conceived in their general design, are marred by detail faults. For instance, on some clutches there is too much overhang from the bearing which carries the clutch shaft and the provision for taking end thrust is insufficient. In one design there is actually no bearing provided to carry the driving plate when the clutch is disengaged, the plate being allowed to ride on the outer periphery of the driven discs, and in some cases the drive is actually taken through small $\frac{1}{8}$-in. pegs which quickly hammer and wear away.

The conventional position of the clutch on a countershaft running at half engine speed is

incorrect. It is hardly necessary to state that if two clutches of similar general design are considered, one being run at engine speed and the other on a countershaft at half engine speed, the former can be made half the effective diameter of the latter and yet transmit the same horse power, provided that the spring pressure remains the same. Alternatively it may be of the same diameter, and be run with half the spring pressure, thus making for easy control and long life of the clutch, or it may have the same spring pressure, and only half the number of friction surfaces, thus reducing the cost and complexity of the component. What advantages are obtained by running the clutch at half engine speed, instead of at engine speed, the author cannot discover, since it is evident that a clutch of the dry plate type, running at engine speed, could be designed to be considerably lighter, and more simple, with a lighter spring pressure, and with far greater durability than any countershaft clutch now known. This question of clutch position appears to be one of the weak points of the modern machine, for there is one make which, although fitted with a countershaft three-speed gearbox of quite usual design, carries the clutch in the back wheel. Actually, of course, the clutch should be run at the highest possible speed, and it is essential that it should be placed between the engine and the gearbox. On some machines a multi-plate clutch is used, which is carried in the gearbox itself, and is on the driven end of the gear train, so that it is, in effect, between the gearbox and the rear wheel, and on the lower gear ratios has to convey the torque obtained by the use of the gear reduction. If the gearbox runs at half engine speed, and the gearbox reduction on first speed is three to one, this clutch will obviously have to transmit no less than six times the maximum engine torque. No wonder that such a clutch is exceedingly heavy, and even then not altogether satisfactory in use, not to mention that it cannot be used to ease the shock of gear changing, and has to be disengaged before the kick-starter can be used. To place a multi-plate clutch in the gearbox is, of course, exceedingly bad practice, for many reasons. It makes the gearbox casing very bulky and heavy, it increases the distance between the main shaft bearings of the gearbox, and it makes the clutch itself inaccessible. In addition, the fine particles of bronze and steel which are worn off the clutch plates in use fall into the gearbox, contaminate the oil, and cause trouble with the bearings, while a very thin oil has to be used in the gearbox itself, since it must also serve for lubrication of the clutch; needless to say, such a thin oil is most unsuitable for gear lubrication, besides being very liable to leak. The clutch in the gearbox, therefore, is not a good proposition, and its use should be abandoned. The ideal clutch would undoubtedly be of the dry plate type, running at engine speed, and using a very light spring pressure.

Gearboxes.

The three-speed countershaft gearboxes, which are now standard practice on nearly all machines except those in the light-weight class, have been developed into quite reliable components, and on the score of durability the gearbox is often superior to the other principal parts of the machine. There are, however, some types in which the bearings are not up to their work, while in others oil leakage is very troublesome. There is one well-known gearbox which fails so badly in the latter respect that it empties itself of all oil in less than a hundred miles, and its exterior is always in a filthy state, so that it is impossible for the rider to use the kick-starter without smearing his clothing with oil. Excessive noise is also a frequent trouble, not merely when the indirect gears are in use, but even when running on top gear. Top gear noises are usually caused by the use of a high-speed layshaft, and also by the adoption of constant mesh gearboxes in which all gears are running in engagement at all times. Whippy shafts, with long bearing centres, gearbox casings of such a shape as to act as sounding boxes, and the use of very coarse pitch gears are other points which cause trouble in this direction. The use of a layshaft carried in the same horizontal plane as the mainshaft is also to be deprecated, since it means that the layshaft gears as well as the mainshaft gears are running in the lubricant; this results in a considerable loss of efficiency through oil churning, and the oil level is brought dangerously near the mainshaft centres, so that oil leakage is difficult to prevent. There seems to be no objection whatever to the use of a layshaft situated vertically below the mainshaft, and this arrangement is actually adopted on several famous machines. All gearboxes, too, should be fitted with an air vent to prevent the rise of air pressure inside the gearbox which will otherwise occur when the gearbox warms up. All designs should, of course, incorporate oil fillers of reasonable diameter and sensible inspection covers. Ease of gear changing is apparently seldom considered when designs are laid out, and more attention needs to be given to this subject, particularly with reference to the size of meshing wheels to give the least possible variation in peripheral speeds at the moment of changing gear, and to the design of dog clutches.

The use of a countershaft gearbox, running at approximately half engine speed, is probably justified by its convenience in relation to the layout of a chain or chain and belt transmission; otherwise, it cannot be defended on technical grounds. The gearbox, like the clutch, should run at the highest possible speed, in order that its bulk and weight may be reduced as far as possible. The adoption of a gearbox running at engine speed, such as is used on one Continental four-cylinder machine, would be a decided step in the right direction, for it is probable that, for equal durability, it could be made one-quarter to one-third of the weight of a box running at half engine speed, and it would, of course, be very much more compact. It would also only impose on the frame reaction stresses of half the magnitude of those which have to be dealt with in the conventional arrangement.

(To be continued.)

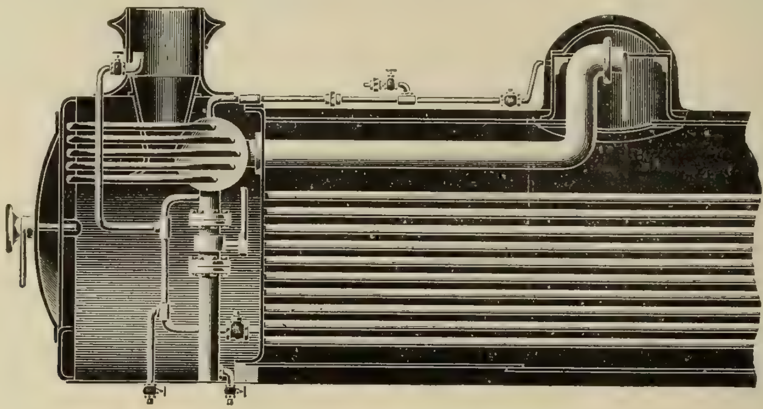
The Swiss journal, *Die Elektro-Industrie*, gives particulars of a process for removing the temper from hardened steel. The piece to be softened is placed on a plate of iron at red heat and covered by a plate of cold iron. After the whole has cooled, the piece of steel, whatever was its previous quality and degree of hardness, is distempered completely, and can easily be worked, without its quality having undergone any change by, for example, decarburisation. The method is specially applicable to the unhardening of tools, more particularly punches and dies. Tests have given excellent results, and the method has the advantage that shaped pieces of steel do not show any shrinkage after treatment.

DEVICE TO PREVENT INJURY TO STEAM SUPERHEATERS.

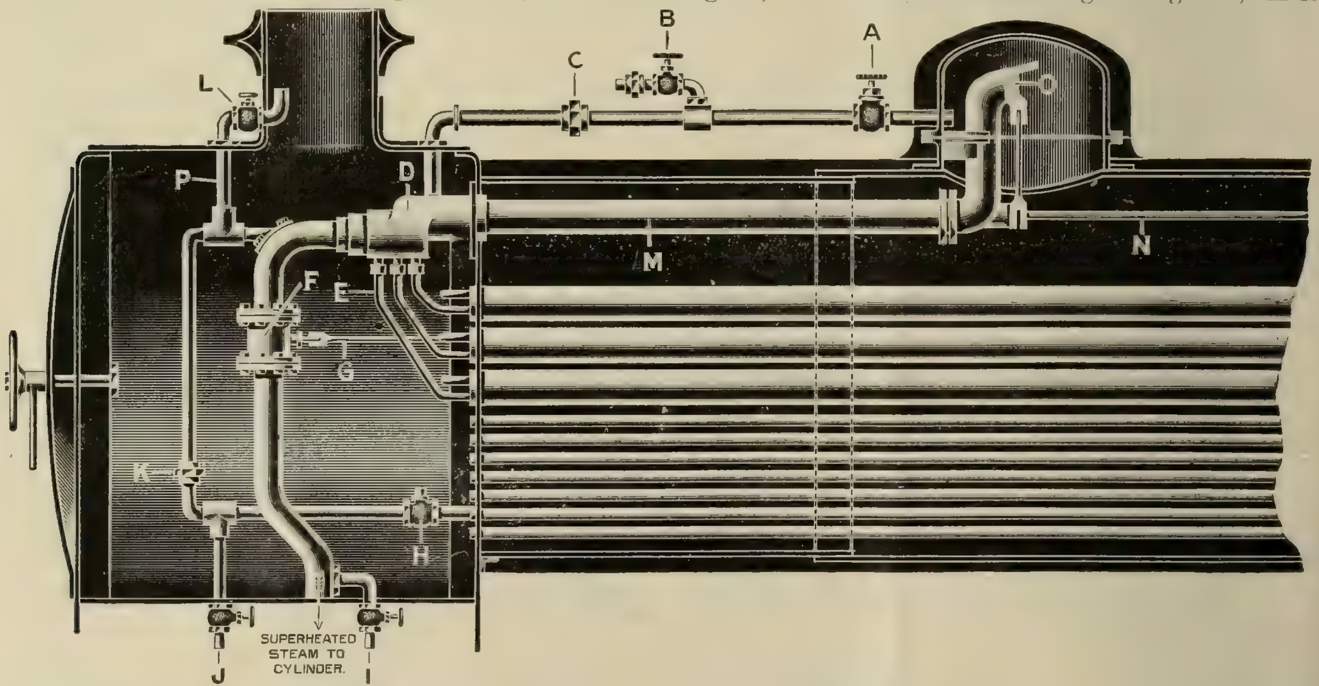
An ingenious invention relating to superheaters for locomotives has been brought to our notice. Its first and chief object is to prevent injury to steam superheaters, due to unequal expansion. Incidentally, the device is said to secure great efficiency and uniformity of action, by improved methods of causing a perfect circulation of steam through the superheater and back to the water inside the boiler, thereby increasing the heat in the boiler considerably, and protecting the tubes from burning and buckling; also preventing them from drawing from the tube plates after they have been expanded in, and the bursting of joints at headers. It is further claimed that an extra valve is placed on the outlet side of the superheater; the ordinary regulating valve is arranged betwixt the boiler and the superheater, and the extra valve between the superheater and the engine, thus admitting superheated steam at full boiler pressure to the engine cylinders.

Fig. 1 shows the invention applied to a smoke-box superheater of a steam traction engine or light locomotive, and Fig. 2 shows it applied to a fire-tubed superheater of a large locomotive.

The valve A admits wet steam from the dome of the locomotive to the superheater header. The valve A is only opened when the engines are standing any length of time, both steam regulators being closed. The valve B is used to admit steam from any other locomotive boiler under steam, which steam is used to bring the water to boiling point during the process of re-filling, when the locomotive has been laid off for cleaning before the fires are lit. D is the superheater header; E, the superheater tubes; F is the extra valve between the superheater and engine; G is the extra valve regulating rod; H is a check valve, returning superheated steam back to the boiler; I is a steam cock between the extra valve and engine cylinder; M is the main steam pipe leading to the superheater.



Device to Prevent Injury to Steam Superheaters.—Fig. 1.



Device to Prevent Injury to Steam Superheaters.—Fig. 2.

A licence to work the patent can be granted on a Royalty basis, enquiries as regards which should be made to John Willoughby and Sons, 34, Albert Terrace, Warwick Road, Batley, Yorkshire.

THE BRITISH SCIENCE EXHIBITION.

There is a good deal to interest the industrial engineer in the British Scientific Products Exhibition now running at the Central Hall, Westminster. Unfortunately, the building is not very suitable for the proper display of the products, and in that respect both exhibitors and visitors have a grievance.

As on the first occasion, there is a unique display of scientific instruments and apparatus, as indeed one is bound to expect in an exhibition organised by the British Science Guild. Firms like Cussons Ltd., of Lower Broughton, show measuring and testing apparatus for engineers. W. H. Allen, Son and Co. Ltd., of the Queen's Engineering Works, Bedford, exhibit a two-cylinder 5 in. by 6½ in. paraffin oil engine direct-coupled to a 6-in. salvage pump capable of delivering 700 gallons of water per minute against a head of 30 ft. It has no special features. Hadfield's Ltd., East Hecla Works, Sheffield, have a fine selection of their well-known steels. C. A. Parsons and Co. Ltd., Newcastle-on-Tyne, have a working model showing installation of geared steam turbine driving a cotton mill. Other models exhibited by this firm relate to their turbines for marine power purposes.

In addition to a neat little petrol-paraffin two-cylinder engine, the Record Engineering Co. Ltd., Burton-on Trent, illustrate their "Record" steam traps with detail parts. This trap differs from the ordinary type, in that the bucket has only to operate a small needle valve, which causes the pressure within the trap to open and close the main valve. The Vaughan Crane Co. Ltd., Openshaw, are drawing attention to the "Vaughan" patent electric block which has been supplied in considerable numbers to Government departments, although it has only been on the market for a short time.

Samples of duralumin are shown by Vickers Ltd., as well as a number of engineers' small tools, electrical accessories, plug screw gauges, and B.L.I.C. magnetos. A coloured scale drawing of a 22-in. reversing mill, operated through their patent reversing pinion housing, is on view for Henry Wallwork and Co. Ltd., Redbank. There is an interesting range of electrical appliances being shown, but too numerous to be detailed here. In the physics section Thermos Ltd., who are the oldest vacuum vessels makers on the market, have an exhibit which covers the various stages of manufacture of a perfect vacuum vessel: (1) The cylinders as first blown at the glassworks; (2) the cylinders cut to size and assembled; (3) the cylinders joined together at the neck and drawn off at the bottom before being exhausted; (4) the cylinders silvered and the exhausting tube fixed; (5) the complete double-walled glass vacuum vessel in various sizes; and (6) examples of some of the cases in use for containing these vessels. As a factor in trench warfare they show a vacuum vessel used very largely during the war for obtaining samples of poisonous gases in the trenches.

A very interesting show is made by Hayter Ltd., 7, Katharine Street, Croydon. This is various applications of the "Hayter" patent cam-lever that forms a universal joint for all parts of any construction that have to be readily accessible or immediately detachable without tools. The inventor claims that this cam-lever movement is a new one. Its uses to which it can be put are very numerous—wall fitments, ports for ships, window fasteners, inspection posts for works, portable buildings, and accessible parts of machinery of every description. On the mechanical side this is probably the most outstanding newcomer to the exhibition. The action is simple, and there is nothing to get out of order; in fact, it is an invention that should come into very general use.

THE WAGE PROBLEM IN INDUSTRY.

By W. L. Hichens

(Chairman of Cammell Laird and Co. Ltd.).

(*Concluded from page 396.*)

The Chairman (Sir George Ranken Askwith, K.C.B., K.C., D.C.L.) said the meeting owed a debt of gratitude to the author for the care and trouble he had taken in dealing with the complex question which he had attacked. He was rather struck by the fact that the author came to the conclusion that the Government must do a very great deal in the matter. There were certain limits to what a Government could do. He was quite sure that in many parts of the country the interference of the Government and of the bureaucrats appointed by the Government had not been very popular during the last few years. The duty of the Government was to exercise the power of amelioration, and, although they might make experiments, as a large employer of labour themselves, in certain directions that might be indicated to them, he doubted whether they could by an Act of Parliament destroy the whole system of the country and build up another. Neither did he think they could interfere continuously between employers and employed, or put before people who must necessarily be at a desk in London agreements which had been made between employers and employed, with a view to their being altered in the interests of the consumer. For years, no doubt, the Government had exercised their powers of amelioration. He noticed a very considerable difference in what had happened in this country since the years 1911 and 1912, when there was a great disturbance in the country. He noticed, too, that employers and employed had organised themselves in a far more effective manner than at that time, and that both were far more inclined to pursue a constitutional course in the attitude they adopted in any disputes they might have. But, although that amelioration had taken place, and there were very great schemes before the country for further amelioration, that had not prevented a considerable amount of industrial unrest. Why was it that the country was so impatient? The author said the chief cause was fear, and up to a certain extent he agreed with that; there was fear, and that fear was coupled with suspicion engendered by disputes extending over many years, and by disputes which were on the eve of breaking out, but which were kept in the background during the war. That fear might take certain forms. There was always the spectre of unemployment, both for a man himself and for his colleagues. There was also a strong feeling that if there was to be increased production the results of that production should not go entirely

to the capitalist class, and that the capitalist should give up more than he had in the past to the wage-earner, in order that the wage-earner might have a better chance in life. There was a fear of going back to exactly the same conditions as those that existed before the war, and there was also a fear that the present high prices might continue, and that the wages paid might not be sufficient to meet the cost of living if wages, which had been greatly enhanced during the war, should by any means be reduced. There was also another cause for the impatience manifested. "Liberty, Fraternity, and Equality" was a "catch-call" at the time of the French Revolution. It was not the words themselves so much as the misapplication of them that might sometimes be in the wrong, and there was no doubt now in the country a feeling that there should be more liberty, in the sense of a better social, economic and political position for the masses of the people, that there should be more equality between class and class, and that what was given to one should be given to another. Sectional advances in wages that had been given in certain places during the war had always been a source of great trouble. During the war there had been a great desire manifested for equality—equality in rationing, in conscription, and in the war wages that had been given to different sections of the community.

Mr. W. L. Hichens, in replying to the discussion, said he quite agreed with the Chairman that the distribution of wealth was the main problem with which the country had to deal, but how was that improved distribution to be brought about? Was it to be brought about by a free fight between one section of the community and the other, or was it to be brought about by some reasoned method? He also agreed with the Chairman that he was throwing a very great responsibility on the Government in suggesting that the ultimate responsibility for determining the relative distribution of wealth as between one section of the community and the other rested on the Government. It was, however, a responsibility that the Government would have to face at some time or other, and it was because they had not faced it in the past but had shirked it during the last century that the country was in the state in which it found itself in to-day. If the Government undertook the task at the moment they would fail completely, because they had not got the community behind them. The community was not educated up to that pitch to-day, but it would have to be educated up to it one day, because the country could not stop short half-way. It could not say: "We quite agree that there should be a better distribution of wealth, but we can suggest no means whereby that can be brought about except a free fight between the parties concerned," which was really the only alternative. Surely the community had got to tackle the problem. Supposing the transport workers, the railway workers, and the miners all all combined together to obtain very much reduced hours and very much increased wages at the expense of the whole community, that situation would have to be dealt with in some way or other. It was no good saying that the employers and the men must negotiate. The employers might not be strong enough to hold their own, or it might be that, in the effort to do so, there would be such a dislocation of the convenience of the public that it would not be possible. He might illustrate his point in the following way: Suppose that A walked into B's house, and said, "I see some very nice silver on your sideboard, and I propose to discuss with you how much of it I shall take." If A were not very eloquent a compromise might be arrived at and he might take only a small proportion. On the other hand, if he were strong enough he might take it all. But there would not be any justice in that at all, and it was the duty of the State to see that he did not take anything that did not belong to him. In the same way, it was the duty of the State to see that neither the employers nor the workers took what did not belong to them. Men could pillage and could commit an act of injustice if they clamoured for more wages or more profits just as much as if they went into another man's house and stole his goods. With reference to Mr. Mundy's remarks with regard to capital, Mr. Mundy suggested that capital would have to be contented with a good deal less than it had had in the past, if indeed it had not to be contented with the heartfelt sympathy of the community, and he indicated that if the worst came to the worst an established business might be able to get on by means of reserves which it might possess at the time or might create. But the trouble was that those reserves were in themselves capital; they were savings; they were the capital belonging to the shareholders of the company, and nobody was going to create reserves to put into a business which had to be contented with "heartfelt sympathy." People wanted interest on their capital, and if they were not given enough interest to satisfy them they would invest their money elsewhere. One of the great features of the war had been the growth of the small investor class. About £600,000,000 had been collected during the war from the smallest class of investors, and, although that was partly due to the spirit of patriotism which had animated everyone during the past few years, that did not alter the situation. Anyone who had done any work in connection with war savings societies would agree that people had to be convinced that it was worth their while financially to invest their money in war bonds or war savings certificates. The small investor had the choice put before him of going to a cinematograph theatre or having a good dinner, or saving his money for a rainy day, and if he was told that he could either have his dinner or put the money into war bonds, in which case it might be confiscated by the community, he would probably choose to have his dinner. If it had to be made worth while to the individual—the human being—to save his money, and the smaller the investor the more the inducement had to be. If people told a man, as they did at the beginning of the war, "Spend 15s. 6d. on a War Savings Certificate, and in five years' time it will become £1," he would prefer to "take the cash and let the credit go," and one could not blame him for that. Rates of interest had had to be raised during the war simply because that was the only way of obtaining the money that was required. The cost of nearly everything had gone up by 100 per cent. An ordinary business had a depreciation fund, and wrote down its machinery during the lifetime of that machinery, but a machine that previously cost £100 would now cost £200 or

£300. That extra money had to be obtained from the pockets of the saving public, and he thought it was a most dangerous doctrine to suggest that capital had got to be contented with whatever it could obtain, because it would not—it would cease to exist at all. With reference to co-partnership, he thought it did not really go to the root of the matter, although he did not want to discourage any experiments that might be tried in that direction. Mr. Priestley himself quite rightly pointed out that there might be a strong combination, practically a monopoly, in any given trade, and he (the speaker) did not agree with Mr. Mundy in thinking that there was no likelihood of such an event taking place in the near future. Assuming such monopolies did exist, Mr. Priestley said that the State would have to step in if the co-partnership scheme in force did not work fairly. If the State did so, it would have to determine whether too much was being paid to the workers in one trade in relation to other trades; therefore the State would have to determine what the wages were to be and on broad lines what the profits were to be, in the way that he had indicated in his paper. Wages disputes took place not merely between capital and labour, but between one section of labour and another, and he did not see how co-partnership was going to determine, for instance, in the shipbuilding industry, how much a carpenter was to have in relation to a riveter. One section of workers obtained more money than another if they had a strong trade union behind them, without reference at all to their skill. Such things should be determined not by brute force, but by some kind of impartially constituted tribunal, and unless public opinion could be educated up to that point, the country would remain in the quagmire in which it found itself to-day.

(Concluded.)

OIL SHALES.*

It has been said, and probably said on good authority, that the great World War was won by petroleum, and we are all more or less familiar with the phenomenal growth of the gigantic industry which has proven itself capable of supplying not only the demands of our own military activities, but in part those of our allies, and at the same time furnishing the fuel for the countless motors and engines used by the people of the United States in commercial and pleasure pursuits. A glance at the figures showing the relation of the amount of petroleum consumed each year to the amount produced reveals the startling fact that the consumption has been rapidly approaching the production, and since 1915 it was even necessary to actually draw on the reserves in storage in order to meet the increased demands, and this while our oil men were straining every nerve to increase the output of petroleum, both by discovering new fields and by developing to the limit the proven areas. The newly-discovered fields have given us an increased production, but the total amount of petroleum derived from these fields has been insignificant in comparison to the total needs of the country. Is it any wonder, then, that men and companies are asking if it is not possible for the oil-shales of the United States to give us relief? After spending nearly five years in studying the oil-shales of the western part of the United States, I am thoroughly convinced that the day is not far distant when these very shales that the cattle men and farmers of the Rocky Mountain region have sworn at so often because they make neither good farm land nor good range, will be yielding oil in sufficient amount to prevent the rapid decline in our total oil production, which is imminent if no new source of petroleum is developed. There seems to be every indication that in the near future (perhaps within 10 years) there will be established in Colorado and Utah an industry for the mining and distilling of oil-shale, which will rival in size any of the mining or manufacturing industries now developed in the United States. At this very time there are at least 75 companies organised for the purpose of manufacturing oil from the shale, and many of these companies are contributing considerably towards the research that will ultimately place the industry on a firm foundation.

Bright as the future seems to be for oil-shales, it must be remembered that before a profit-paying industry is established, large sums of money must be expended in the development of processes and practical machinery for extraction of the valuable products of the shale. The cost of producing shale oil must include such items as mining, transportation of the raw shale from the mines to the retorting plant, crushing, retorting, condensing, manufacture of ammonium sulphate and disposal of the spent shale, which will weigh at least 60 per cent as much as the shale as it comes from the mines, and will probably be only slightly less bulky.

Unfortunately, the word "oil-shale" brings to the mind of the uninitiated visions of wealth similar to the wealth that has come to those oil men who have been fortunate in making strikes in the oil fields. The oil-shale industry is to be more like the great Bingham, Utah, copper district, where thousands of tons of low-grade ore are handled daily, and where each ton yields only a small profit. Enormous capital will be required to establish a profitable oil-shale plant, and men with small means should be very careful before investing it in oil-shale to be sure that the company in which they invest has ample capital and good, sound, thorough men at the head who are willing to spend large sums in experimental work before returns are forthcoming.

Several years before the first discovery of petroleum in 1857, "coal-oil" was being made from cannel coal and black shale in the eastern part of the United States, and it is reported that at the time of the first discovery of petroleum sixty companies had been organised and many of them equipped with the necessary machinery for making oil from the rocks, but the newly-discovered fuel proved so cheap that all these attempts at manufacturing oil were abandoned. Recently, the increased demands for petroleum and the high price paid for gasoline, fuel oil, etc., have revived the idea that it may be both practical and profitable to distil oil from the rocks. This time attention is being directed largely toward the rich oil-shales of the Rocky Mountain States.

(To be continued.)

* A paper by Dean E. Winchester, Geologist, U.S. Geological Survey, presented at the meeting of the Franklin Institute held Wednesday, February 19th, 1919, and published by permission of the Director, U.S. Geological Survey.

NEW LABOUR CONDITIONS IN CANADA.*

When serious labour disturbances appeared on the horizon a few weeks ago the Canadian Government set up two Commissions of Inquiry in an effort to head off trouble: first a Commission on Industrial Relations, and later a Parliamentary Committee to inquire specifically into the cost of living.

Both these bodies have within the last few days made reports. What effect these reports are going to have on the situation remains to be seen. At the moment the labour situation, while far from quiescent, as fresh strikes are breaking out every few days, is less disturbed than it has been since May 1st.

Both the inquiring bodies have been working under pressure. Judging from the haste with which they were pitchforked into their tasks and with which they turned out their report, it might be supposed some impending catastrophe was feared.

Compared with the United States report on Industrial Relations prepared in 1912, the report of the Canadian Commission of 1919 on the same subject appears inadequate. Instead of the eleven bulky volumes with their eleven thousand two hundred and sixty pages which comprise the American Report, the Canadian document consists of a Parliamentary paper comprising twenty-five pages all told. The evidence has not been printed, and there seems to be grave doubt that it ever will be.

The report makes recommendations that would have sounded revolutionary before the war or, for that matter, even a year ago, and to-day strike many as extraordinarily and unnecessarily radical. Two members of the Commission itself refused to sign the majority report, which has, however, five signatures, including the Chairman, Chief Justice Mathers, of Manitoba, the three Labour representatives, and one of the representatives of employers and capital.

Main features among their recommendations are:—

1. Minimum wage for everybody, including unskilled labour, women and girls.

2. State insurance against unemployment, sickness, invalidity, old age.

3. The eight-hour day (apparently not the 44-hour week which has already been adopted by some firms. Notable in this connection is the T. Eaton Company, the largest department store in Canada, which in addition to giving Saturday afternoon off all the year around is this year during July and August closing all its stores and factories all day Saturday, thus making a five-day week).

4. Collective bargaining.

5. Provision of an equal opportunity in education.

6. Proportional representation in Parliament (the sole political recommendation).

7. Industrial Councils.

8. Restoration of fullest liberty of freedom of speech and press.

The chief causes of unrest as listed by the Commission form one of the most interesting sections of the report. These causes are given as:—

1. Unemployment and fear of unemployment.

2. High cost of living in relation to wages and the desire of the worker for a large share of the product of his labour.

3. Desire for shorter hours of labour.

4. Denial of the right to organise and refusal to recognise unions.

5. Denial of collective bargaining.

6. Lack of confidence in constituted Government.

7. Insufficient and poor housing.

8. Restrictions upon the freedom of speech and press.

9. Ostentatious display of wealth.

10. Lack of equal educational opportunities.

The Cost of Living Committee was instituted because of an angry chorus of complaints which burst against the legislators originating in disappointment when peace brought prices soaring over even wartime levels, and because of a prevalent conviction that herein lay the chief exciting cause of unrest.

The Committee was a Parliamentary Committee appointed in pannicky haste, which carried on its inquiry in a scramble, apparently without method, and devoted many of its sessions to noisy wrangles. Its report was just what might have been expected under the circumstances. In the first place it was so irregular that its legitimacy was questioned. And, secondly, the gist of the report itself was first that nothing could be really done about high prices, for prices were never going to revert to old levels, and second that two specific measures looking to the control of prices ought immediately to be inaugurated.

The measures recommended were the adoption of a new Act against combines and the establishment of a Board of Commerce to be set up to investigate charges that combines exist. Canada for twenty years or more has had an Act against combines. But it has been largely a dead letter, because it put upon private individuals the onus and the expense of producing the evidence and, indeed, of instituting the prosecution. The Act itself was one which few people found any difficulty in keeping within. The new Act is said to be tightened up a good deal, though the proof will only come in practice. The Board of Commerce will, it is expected, provide the evidence more or less automatically, after which presecutions will be handled by the regularly constituted departments of justice.

Apparently the machinery has been provided for a real control of prices and prevention of extortion, something that was non-existent in war-times.

The public is awaiting with keen interest the operation of these measures. Revelations of huge profits by the Cost of Living Committee, even in its haphazard inquiry, confirming officially widely-spread impressions, aroused resentment so strong that one rumour was that in its later sessions the Committee pressed the soft pedal lest its proceedings inflame public opinion unduly. If the new machinery will provide a remedy the public wants to see the wheels going round.

* "Manchester Guardian," July 26th, 1919.

Weights of Lengths of Rolled Steel Sections.

Beam 8 in. × 5 in. × 27 lbs. per foot.

NEW SERIES.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 1 18	4 3 8	7 0 26	9 2 16	12 0 6	14 1 24	16 3 14	0 19 1 4	1 1 2 22	0
1	0 0 27	2 2 17	5 0 7	7 1 25	9 3 15	12 1 5	14 2 23	17 0 13	0 19 2 3	1 1 3 21	1
2	0 1 26	2 3 16	5 1 6	7 2 24	10 0 14	12 2 4	14 3 22	17 1 12	0 19 3 2	1 2 0 20	2
3	0 2 25	3 0 15	5 2 5	7 3 23	10 1 13	12 3 3	15 0 21	17 2 11	1 0 0 1	1 2 1 19	3
4	0 3 24	3 1 14	5 3 4	8 0 22	10 2 12	13 0 2	15 1 20	17 3 10	1 0 1 0	1 2 2 18	4
5	1 0 23	3 2 13	6 0 3	8 1 21	10 3 11	13 1 1	15 2 19	18 0 9	1 0 1 27	1 2 3 17	5
6	1 1 22	3 3 12	6 1 2	8 2 20	11 0 10	13 2 0	15 3 18	18 1 8	1 0 2 26	1 3 0 16	6
7	1 2 21	4 0 11	6 2 1	8 3 19	11 1 9	13 2 27	16 0 17	18 2 7	1 0 3 25	1 3 1 15	7
8	1 3 20	4 1 10	6 3 0	9 0 18	11 2 8	13 3 26	16 1 16	18 3 6	1 1 0 24	1 3 2 14	8
9	2 0 19	4 2 9	6 3 27	9 1 17	11 3 7	14 0 25	16 2 15	19 0 5	1 1 1 23	1 3 3 13	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	0 2·25	0 4·50	0 6·75	0 9·0	0 11·25	0 13·5	0 15·75	0 18·0	0 20·25	0 22·5	0 24·75	0 27	

Weights of Lengths of Rolled Steel Sections.

Beam 8 in. × 5 in. × 27 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	1 4 0 12	2 8 0 24	3 12 1 8	4 15 1 20	6 0 2 4	7 4 2 16	8 8 3 0	9 12 3 12	10 16 3 24	0
10	0 2 1 18	1 6 2 2	2 10 2 14	3 14 2 26	4 18 3 10	6 2 3 22	7 7 0 6	8 11 0 18	9 15 1 2	10 19 1 14	10
20	0 4 3 8	1 8 3 20	2 13 0 4	3 17 0 16	5 1 1 0	6 5 1 12	7 9 1 24	8 13 2 8	9 17 2 20	11 1 3 4	20
30	0 7 0 26	1 11 1 10	2 15 1 22	3 19 2 6	5 3 2 18	6 7 3 2	7 11 3 14	8 15 3 26	10 0 0 10	11 4 0 22	30
40	0 9 2 16	1 13 3 0	2 17 3 12	4 1 3 24	5 6 0 8	6 10 0 20	7 14 1 4	8 18 1 16	10 2 2 0	11 6 2 12	40
50	0 12 0 6	1 16 0 18	3 0 1 2	4 4 1 14	5 8 1 26	6 12 2 10	7 16 2 22	9 0 3 6	10 4 3 18	11 9 0 2	50
60	0 14 1 24	1 18 2 8	3 2 2 20	4 6 3 4	5 10 3 16	6 15 0 0	7 19 0 12	9 3 0 24	10 7 1 8	11 11 1 20	60
70	0 16 3 14	2 0 3 26	3 5 0 10	4 9 0 22	5 13 1 6	6 17 1 18	8 1 2 2	9 5 2 14	10 9 2 26	11 13 3 10	70
80	0 19 1 4	2 3 1 16	3 7 2 0	4 11 2 12	5 15 2 24	6 19 3 8	8 3 3 20	9 8 0 4	10 12 0 16	11 16 1 0	80
90	1 1 2 22	2 5 3 6	3 9 3 18	4 14 0 2	5 18 0 14	7 2 0 26	8 6 1 10	9 10 1 22	10 14 2 6	11 18 2 18	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t c. q. lbs.	Weight.
	12 1 0 8	24 2 0 16	36 3 0 24	48 4 1 4	60 5 1 12	72 6 1 20	84 7 2 0	96 8 2 8	108 9 2 16	120 10 2 24	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 8in. × 5 in. × 27·5 lbs. per foot.

NEW SERIES.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 1 23·0	4 3 18·0	7 1 13·0	9 3 8·0	12 1 3·0	14 2 26·0	17 0 21·0	0 19 2 16·0	1 2 0 11·0	0
1	0 0 27·5	2 2 22·5	5 0 17·5	7 2 12·5	10 0 7·5	12 2 2·5	14 3 25·5	17 1 20·5	0 19 3 15·5	1 2 1 10·5	1
2	0 1 27·0	2 3 22·0	5 1 17·0	7 3 12·0	10 1 7·0	12 3 2·0	15 0 25·0	17 2 20·0	1 0 0 15·0	1 2 2 10·0	2
3	0 2 26·5	3 0 21·5	5 2 16·5	8 0 11·5	10 2 6·5	13 0 1·5	15 1 24·5	17 3 19·5	1 0 1 14·5	1 2 3 9·5	3
4	0 3 26·0	3 1 21·0	5 3 16·0	8 1 11·0	10 3 6·0	13 1 1·0	15 2 24·0	18 0 19·0	1 0 2 14·0	1 3 0 9·0	4
5	1 0 25·5	3 2 20·5	6 0 15·5	8 2 10·5	11 0 5·5	13 2 0·5	15 3 23·5	18 1 18·5	1 0 3 13·5	1 3 1 8·5	5
6	1 1 25·0	3 3 20·0	6 1 15·0	8 3 10·0	11 1 5·0	13 3 0·0	16 0 23·0	18 2 18·0	1 1 0 13·0	1 3 2 8·0	6
7	1 2 24·5	4 0 19·5	6 2 14·5	9 0 9·5	11 2 4·5	13 3 27·5	16 1 22·5	18 3 17·5	1 1 1 12·5	1 3 3 7·5	7
8	1 3 24·0	4 1 19·0	6 3 14·0	9 1 9·0	11 3 4·0	14 0 27·0	16 2 22·0	19 0 17·0	1 1 2 12·0	1 4 0 7·0	8
9	2 0 23·5	4 2 18·5	7 0 13·5	9 2 8·5	12 0 3·5	14 1 25·5	16 3 21·5	19 1 16·5	1 1 3 11·5	1 4 1 6·5	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs. 2·29	lbs. 4·58	lbs. 6·87	lbs. 9·16	lbs. 11·45	lbs. 13·75	lbs. 16·04	lbs. 18·33	lbs. 20·62	lbs. 22·91	lbs. 25·20	lbs. 27·5	Weight.

Weights of Lengths of Rolled Steel Sections.

Beam 8in. × 5 in. × 27·5 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	1 4 2 6	2 9 0 12	3 13 2 18	4 18 0 24	6 2 3 2	7 7 1 8	8 11 3 14	9 16 1 20	11 0 3 26	0
10	0 2 1 23	1 7 0 1	2 11 2 7	3 16 0 13	5 0 2 19	6 5 0 25	7 9 3 3	8 14 1 9	9 18 3 15	11 3 1 21	10
20	0 4 3 18	1 9 1 24	2 14 0 2	3 18 2 8	5 3 0 14	6 7 2 20	7 12 0 26	8 16 3 4	10 1 1 10	11 5 3 16	20
30	0 7 1 13	1 11 3 19	2 16 1 25	4 1 0 3	5 5 2 9	6 10 0 15	7 14 2 21	8 19 0 27	10 3 3 5	11 8 1 11	30
40	0 9 3 8	1 14 1 14	2 18 3 20	4 3 1 26	5 8 0 4	6 12 2 10	7 17 0 16	9 1 2 22	10 6 1 0	11 10 3 6	40
50	0 12 1 3	1 16 3 9	3 1 1 15	4 5 3 21	5 10 1 27	6 15 0 5	7 19 2 11	9 4 0 17	10 8 2 23	11 13 1 1	50
60	0 14 2 26	1 19 1 4	3 3 3 10	4 8 1 16	5 12 3 22	6 17 2 0	8 2 0 6	9 6 2 12	10 11 0 18	11 15 2 24	60
70	0 17 0 21	2 1 2 27	3 6 1 5	4 10 3 11	5 15 1 17	6 19 3 23	8 4 2 1	9 9 0 7	10 13 2 13	11 18 0 19	70
80	0 19 2 16	2 4 0 22	3 8 3 0	4 13 1 16	5 17 3 12	7 2 1 18	8 6 3 24	9 11 2 2	10 16 0 8	12 0 2 14	80
90	1 2 0 11	2 6 2 17	3 11 0 23	4 15 3 1	6 0 1 7	7 4 3 13	8 9 1 19	9 13 3 25	10 18 2 3	12 3 0 9	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	12 5 2 4	24 11 0 8	36 16 2 12	49 2 0 16	61 7 2 20	73 13 0 24	85 18 3 0	98 4 1 4	110 9 3 8	122 15 1 12	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

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SCIENTIFIC LIGHTING AND INDUSTRIAL EFFICIENCY.

In a lecture on "Scientific Lighting and Industrial Efficiency," at the British Scientific Products Exhibition, Central Hall, Westminster, on July 28th, Mr Leon Gaster pointed out the close relation existing between good industrial lighting and the health of workers, and gave many instances of accidents due to insufficient or badly arranged conditions of illumination. Light, he said, was a "tool," and it was absurd to instal expensive machinery and to pay highly skilled workmen, and then to neglect the relatively small expenditure on illumination necessary to the efficient performance of work. Instances were quoted showing that, as a result of improved lighting conditions, increases in output of 8-27 per cent had been recorded, and another factor of importance was the reduction in the amount of spoiled work. The cost of lighting formed only a small proportion, in some cases less than one per cent of the wages bill. Good industrial lighting was therefore amply justified on economic as well as on humanitarian grounds. Mr. Gaster recalled that, previous to the war, enquiries into industrial lighting were being initiated by several of the chief European countries, and in the case of Great Britain, the Departmental (Home Office) Committee on lighting in factories and workshops had been duly formed, and had issued a most valuable interim report in 1915. In this report it was suggested that there should be statutory provision to secure adequate lighting in factories, and it was hoped that a reference to the matter would be inserted in the Factory Act in the near future. During the war considerable progress had been made in the United States, where five States had already adopted legislative codes on industrial lighting. He hoped, therefore, that this country would shortly regain the lead which it formerly held. Judicious measures of this kind would be welcomed by worker and manufacturer alike, and ought ultimately to be the subject of international action, together with other matters affecting the health and efficiency of the workers of the world. At the present time, when the need to increase our production was so great, and when the necessity of saving fuel was so evident, the applications of scientific methods to factory lighting was of special importance. During the last ten years much useful information had been acquired by the Illuminating Engineering Society in this country, one very important step being the development of simple instruments for measuring illumination. The Illuminating Engineering Society is in a good position to render assistance in making clear the essentials of good industrial lighting, by means of lectures and demonstrations.

LEATHER BELTING.

Hitherto it has been the English custom to sell leather belting chiefly by weight, and where sold by measurement leather belting has usually been sold without any specified thicknesses. Both of these systems are so obviously open to objection from a buyer's point of view, and both have such weak points compared with some of the Continental systems, that the Federation of Leather Belting Manufacturers of the United Kingdom have decided that after September 1st, no leather belting shall be sold except on the basis of the new National Price List, which quotes for all widths of belting per foot, with thicknesses specified according to the customers' requirements and the purpose for which the belting is intended.

Copies of the new list will be circulated to all buyers in the Kingdom before September 1st, and the Federation feels that the change will be welcomed by buyers, who will in future know exactly what their belting is going to cost them, and exactly what is going to be supplied for the money.

It has long been an anomaly that all other classes of belting have been sold by measurement, with thicknesses or plies specified. The change is being made by the Federation entirely in buyers' interests, and with a view to bringing the Leather Belting Trade of the United Kingdom up to the highest possible standard in the early days of reconstruction.

ON STANDARDISATION AND STOCK.

By W. Roland Needham.

(*Concluded from page 289.*)

In any industrial reconstruction worthy the name it would seem that consideration for others and self-interest are twin sisters, that what Henry Drummond called "The struggle for life," and "The struggle for the life of others" go hand-in-hand. If we are to enjoy peace and accord, each section must cultivate a larger outlook. Our concern must be fair play all round. If each really wishes the other chap to have a decent look-in, the future is full of promise. This is the truly constructive, the essentially positive temper. It is not merely idealistic; it is within the range of practical and practicable policy. For Capital and Labour to waste their energies and resources in internecine strife is fatal to the interests of each. Such a dog-in-the-manger policy is suicidal. Let them swim or sink together, win each other's esteem through the media of good faith and of good work, seek each a fair return for honest effort, be enterprising and straight, and the result will be much more swim than sink.

To resume, however, where a finished machine cannot as a whole be put through as a standard, and therefore stock product, if only considerable portions of it are standard, then an appreciable economy can be effected. Many customers exhibit a marked predilection for special features. Some of these innovations are radical, others paltry. It is always advisable, wherever possible, to satisfy the peculiar requirements of purchasers, actual or prospective. Where they express any strong preference for some particular departure, it is well, if it can be done, to meet them in the matter. At the same time, however, the manufacturer, if he is wise, will frequently offer the customer the choice between the special machine at a special price, and an equivalent standard machine, functioning as well or better, but considerably cheaper. In many cases the standard or stock article is preferred. Thus it frequently happens that while the purchaser has his way, the manufacturer, like the diplomatic wife, smiles no less in that the customer's way is his way also.

How many public companies realise the value of sufficiently and correctly particularised stock lists? These records should be regularly and frequently circularised through the various departments concerned, together with precise and firm instructions concerning their purpose and use. Attention to these matters should be insisted upon. One highly desirable form of economy is the careful and discriminating use of old stock. If this side of the business be in charge of men wide awake, informed, enthusiastic, and sufficiently assertive, excellent results will follow. The two essentials are that those who undertake the task, like it and take pains with it, and that accurate and adequate records be kept and utilised. It is not a "cushy" job, nor to the majority of men, a congenial one. To the right man, however, it is just the job he can make and the job which can make him. I know of a case where great economies have been effected, old stock used in, principally by reason of the keen, far-seeing policy and activities of one man. What this can mean in the way of housing room for current stock, any storekeeper with limited accommodation and increasing supplies can readily appreciate.

Considerations such as these, trivial as they may seem, are not really unimportant. There may be some unavoidable interference with strictly standard work, but it need only be incidental. Here again it is a case for carefully weighing the pros and cons of the matter. We should learn to test things on their merits, and to act accordingly.

In conclusion, one thing especially must not be overlooked, and that is the psychological factor in it all. Psychology is seen to count tremendously in education; it is certainly no less important in commerce and industry. If all we have urged is seriously put to the test on anything like a large scale, how will it affect those most intimately concerned, *i.e.*, the producers themselves? They are striving after a shorter working day, a higher relative return for their labour, and arising out of these things, scope and opportunity for the fuller life they hope just reform will render possible for them. Now I think it is more or less generally accepted that a price will have to be paid, and no section of the community is likely to escape scot free. The workers' share of the burden will be the sameness, the monotony of automatic and repetition operations which standard work entails. Everything should be welcomed which can be conveniently introduced to stimulate the interest of the operatives in their work. One ever-fruitful source of indifference, of listlessness, is ignorance of the *motif* and the meaning behind it all. How few of us can use, much less like, the Calculus? I who write confess to a tedious struggle through the Differential Calculus, and a most undignified capitulation when, at last, I bungled even a little way through Integration. We are afraid of the Calculus, cannot see what on earth

it is all about; even if we can use it, we don't seem to know exactly what to use it for. Show a youth how to employ it usefully, however, and if he be that way built, it becomes a new, a wonderful instrument in his hands. Work intelligently performed must justify itself, or rather those who produce it. What awakens interest is of prime importance, however considered; and a worker will often accept cheerfully the drabbest drudgery for the prospect it opens out upon, and the return it yields. Knowing what it is he does, why it is done, and whither it all tends, a man will turn out better work, and work he prides himself in. It is well worth while to foster such a spirit and temper.

(*Concluded.*)

ELECTRO-PLATING ON IRON FROM COPPER SULPHATE SOLUTION.

By O. P. Watts.

For electro-plating on iron or steel from a copper sulphate solution, platers have in the past found it necessary either to give the metal a preliminary coat of nickel or to plate it with copper from a cyanide solution before transferring the object to the copper sulphate plating bath. Since the sulphate solution is much more satisfactory than the cyanide for the production of heavy deposits of copper, where these are required the plater has been compelled to maintain two different plating solutions, and to perform two distinct plating operations. The desirability of being able to plate directly on steel in the copper sulphate solution is apparent, and many persons have tried to discover a method of doing so, but until recently without success.

It has been discovered recently that by immersing iron for a few moments in an acidified solution of arsenious oxide, an adherent copper-plate may be deposited from an acid electrolyte, but no adequate explanation had been offered for this unique effect of arsenic. In this paper it has been shown that certain solutions of lead and antimony may be substituted for the arsenic dip, previous to direct-current plating of copper on iron from copper sulphate.

It appears to be impossible to obtain a perfect plate on iron from solutions of bismuth chloride by the usual methods of electro-plating; but use of the arsenic or antimony dip is attended with the same successes as in copper plating.

The successful substitution of solutions of antimony and lead arsenic, and the application of these dips to plating on iron with bismuth, show that the beneficial effect of the arsenic dip is not due to a property peculiar to arsenic alone, but is the result of coating the iron with a metal whose potential in acid solutions is so near to that of copper that it is possible to deposit a good copper plate upon it, yet whose potential is not so far below iron that it will deposit on iron in a powdery, non-adherent form.

Crude Oil Engines Ltd. (156,123).—Registered June 17th. apital £30,000, in 200,000 ordinary shares of 2s. and 10,000 preference shares of 1. To acquire the sole manufacturing rights of an engine known as a "crude oil engine." Engineers, etc. Agreement with H. W. Robinson and G. F. Underwood. First directors: H. W. Robinson, G. F. Underwood, and L. Alexander Office: 5, Fenchurch Street, E.C.

THE INDUSTRIAL SITUATION.

Whether we like it or not (and some of us do not like it), the recent Labour Conference at Southport marked the commencement of a new era in industrial affairs, and the discussions which took place proved the desire on the part of many of the delegates to test the efficiency of what is called "direct action." Many sections of the organised workers are showing, just now, a marked preference for the "strike policy," as against a policy of "negotiation."

Anyone who has had to go through the terrible ordeal of a lengthy strike or lockout will deplore any return to such methods, knowing the bitter cost of anything gained by such means. The strike is a two-edged weapon, very often inflicting greater injury to those who use it than it does to those it is used against. Strikes inevitably means loss, privation and misery to the workers, and the effects of such action is sometimes acutely felt for years after.

As one who had an intimate knowledge of the great Engineering Trades Dispute of 1897, I am not likely to forget the terrible incidents of that period; and I may say frankly, that I hope and trust never to see the like again. The losses sustained, both by employers and employed, in that lamentable struggle, were incalculable, and I question if the engineering industry has yet recovered from the effects of it.

A few of the things it was responsible for are worthy of repetition at this juncture. First, it opened wide the door for the introduction into this country of machine tools and engineering plant of American and Continental manufacture, with the result that the makers of such obtained a footing in British and Colonial markets which they have never lost, but as the years went on, have made increasingly strong and secure. Secondly, it engendered, by its very bitterness, that system of distrust and "armed neutrality," which is still evident between employers and employed, and which characterises the various discussions which take place between their representatives. This feeling is the great stumbling block to an approximation of each others point of view, and until it is entirely eliminated, and its place taken by a firm belief in each others honesty of purpose, matters arising of a contentious matter will inevitably lead to bitterness. So long as a belief exists that each side of the table is out to exploit the other, no real or genuine progress is possible, but an earnest desire to give each other credit for honesty of purpose will have the effect of bringing about straight forward discussion, and a display of commonsense in tackling matters of a contentious character.

But a strike or lock-out is the policy which indicates either a bad case or bad handling of a good one. In any case, it tends to intensify rather than diminish class hatred.

Be this as it may, the recent actions of the cotton operatives and employers, and the present bellicose attitude of the miners, makes it clear that a large section of the organised workers are determined to try the effects of "direct action," the feeling being that the hope of achieving better conditions by means of political action has proved to be a delusion and a snare.

The principal factor in bringing about this

feeling has been, what many regard, as the failure of the labour representatives in the House of Commons to take advantage of the opportunities they have had, to place the workers case clearly and concisely before that assembly. Further, the great mass of workers consider that they have been wilfully misled by the specious promises held out to them by persons responsible for the Government of the country. That such promises were made purely for election purposes, and with no intention on the part of those who made them, to see that they were fulfilled

And as things stand at present they have good grounds for complaints. There was to be an end to militarism, but we have a new military service act, and the exposure of secret military documents inimicable to labour, and the continued backing up, on the part of the present Government, of the forces of re-action in Russia. All these are factors in the make-up of the present industrial unrest. Other factors can be found in the continued high prices of commodities, coupled with a considerable amount of barefaced profiteering in the common necessaries of life. Such grievances contain all the elements of a revolution, and it behoves those who are responsible to get a move on, and see that such grievances are remedied. Moreover, the presence of many thousands of demobilised soldiers and sailors wanting employment, and unable to obtain it, is a standing menace to public security. The recent happenings at Luton, Doncaster, and other places were indications of what will happen in a greater degree, unless the situation is dealt with in a honest and straightforward manner. The want of sympathy these men have experienced at the hands of official persons is, after all they have suffered on behalf of the community, to say the least of it, discreditable to us as a nation or an empire.

The present position, to my mind, is an intolerable one in every sense, and can only be improved by the sane and united efforts of the entire community.

As a result of the war, we find the tonnage of our mercantile marine seriously depleted, and the immense loss of life meant that hundreds of thousands of potential producers were for ever lost to the nation. Yet with all this leeway to make up, and with a decreased number of available workers, we find that there are more than one million of the workers without employment. This, I contend, is the most serious aspect of things.

Within the bounds of the Empire we have almost inexhaustable resources, and side by side with these we have an immense amount of labour waiting to be employed. Surely we should be capable of organising the development of our resources, and incidentally of using in the process, this surplus labour. The question is, what prevents us doing it?

It seems to be anybody's job, or everybody's job, and that eventually means nobody's job: but we may rest assured that it must be somebody's job.

There can be no real attempt at reconstruction, on either an imperial or national basis, until this bogie is got rid of.

Speaking of the fullest development of our resources, brings us to the action of the Yorkshire miners.

The stoppage of the pumping plants is both silly and unwarrantable, and it may, and probably will, bring increased hardships to thousands of workers, who are in no wise responsible; nor is it likely to achieve the result its authors imagined. One thing it cannot fail to do, is to accentuate the already serious shortage of coal supplies, and it will also have the effect of reducing the miners earnings. Nor is the introduction of naval units into the strike area likely to effect much good, and may easily be productive of very much harm.

This matter closely affects the whole of the community, and other sections of the workers would do well to ponder the effects of such action, so far as they themselves are concerned. The miners will find that even a Sankey Commission does not necessarily imply an industrial millenium, but that better conditions of labour can only be obtained through loyal co-operation between capital and labour. Even then, it must be a steady evolutionary movement, and not a spasmodic rush into new conditions, for which no time has been allowed in making of the necessary prepartions required by the changed circumstances. These remarks apply equally to those in other than the coal industry.

In the engineering trade matters are being brought forward for discussion which may have far-reaching effects so far as the entire industry is concerned. The further shortening of hours is a question which requires much careful consideration, and it is desirable that matters in this connection should not be rushed. From present indications it will take all the tact and diplomacy on both sides to prevent a rupture, but if the negotiations are conducted in a spirit of fairness, a compromise might be effected satisfactory to all concerned. If, as a result of the said negotiations, an agreement is arrived at, let such agreement be loyally and honestly abided by, and its provisions carried out to the letter by both sides. If the duly appointed representatives of both sides are parties to a bargain, then it is up to their constituents to carry out its provisions in every particular.

A matter which is very regretable is the attempt on the part of a few interested individuals to forment trouble between the military and civilians on matters of an industrial character.

In some cases it is caused by a total lack of knowledge, but in others I am afraid it is being carried on from interested motives. Such action deserves the greatest condemnation from those desiring industrial peace, and any attempt to create antagonism on these lines should be ruthlessly suppressed. On the other hand, all that makes for unity, peace and genuine reconstruction should be encouraged by every possible means.

To the advocates of "direct action" I would say, "beware the boomerang."

THE AUDION AMPLIFIER.

For more than 20 years telephone engineers had sought in vain a repeater or amplifying relay, which would be at once extremely sensitive, free from delicate and frequent adjustments, and yet would amplify every modulation of the human voice without distortion. Without such a relay, a telephone at that time was limited to a few hundred miles. This problem of the telephone had

baffled all the numberless inventors and engineers in the telephone industry. It was an elusive will-o'-the-wisp which looked so simple, and yet defied their most praiseworthy efforts. So keen did the search become and so hopeless seemed the solution, that an eastern telephone company in the nineties offered one million dollars for a successful telephone relay. The prize was never awarded, or claimed. Almost without exception these telephone engineers and inventors attacked the problem from the same angle. They saw one method which afforded a solution. That was to associate in some manner the elements of the well-known telephone receiver and telephone transmitter or carbon microphone. The method was a mechanical one which always in the final analysis failed.

We are indebted to the "wireless" for the revolution in ideas telephonic which alone enables one to talk from San Francisco to New York. In 1902 Dr. Lee de Forest, in the course of his experiments with wireless detectors, discovered that a heated gas was "sensitive" to weak "wireless" waves, and could constitute a new detector for use in radio-telegraphy. In 1903-04 he made over this principle a genuinely practical detector, possessing a sensitiveness far exceeding that of any previously known wireless receiver. He found that when this device, altogether new to the telephone field, was properly connected in the line between a transmitter and a receiver, the audion amplified the voice currents, giving a reproduction of perfect fidelity without a trace of lag or distortion. The audion amplifier was patented in 1907, but it was not till 1912 that the inventor deemed it sufficiently developed to bring it to the attention of the engineering staff of the American Telephone and Telegraph Company. In 1913 announcements were made that the long-dreamed-of Transcontinental line was to become a reality.

The audion amplifier consists of a small incandescent lamp bulb exhausted of air, which contains, in addition to the usual filament, two thin plates of nickel about one-eighth of an inch from the filament on each side. Between the filament and the plates are two pieces of nickel wire bent grid-shaped. The incoming current, to be repeated and amplified, is conducted to the "grid" wire. The outgoing line is connected, one terminal to the plates, the other to the filament. In this circuit is found a battery. A separate battery lights the filament to incandescence. The heated gas becomes then a conductor of the local current from the battery which can pass from the cold plates to the hot filament. That is, negatively charged "carrier," "ions," or "thermions," as they are termed, speed in invisible streams of almost infinite tenuity from filament plates, passing in their migration through the spaces between the wires of the grids. The slightest electrical potential, or charge of electricity impressed upon these grids from the incoming telephonic currents, deflects or retards some of these minute carriers of negative electricity. This effect is always proportional to the cause, so that the current changes produced in the outgoing or "plate" circuit are exactly similar to those current changes or electric charges upon the grid which produced them. In other words, a unit electrical charge delivered upon the "grid" produces a deflection or stoppage of six to ten unit electrical charges passing from the filament to the plates.

The de Forest audion is to-day receiving wireless messages in New York, and at the great naval station at Arlington, Va., from San Francisco; Nauen, Germany; Paris, France, and from the radio stations in the Pacific Ocean. Transoceanic telephony by submarine cable, with numerous Pupin coils and the audion amplifier is theoretically possible; commercially an utter impossibility. The cost of such a cable would be prohibitive. Transoceanic wireless telephony, however, is to-day almost within our reach.

SOLDERS FOR ALUMINIUM.

The question is frequently raised in connection with the use of aluminium and its alloys whether they can be satisfactorily soldered, and if so, by what method and with what metals or alloys. Aluminium, and to a greater extent its alloys, can be welded quite satisfactorily by the oxygen-gas process, but often it is not desirable to heat the parts to be joined to the relatively high temperature necessary to weld them in this manner, owing to the resultant distortion of the parts, and a means of joining at lower temperatures is sought. In response to the general interest in the utilisation of this method, evidenced by the inquiries which are received, the Bureau has gathered data on the subject, based upon current experience, and made special tests which are here summarised:—

All metals or combinations of metals used for aluminium soldering are electrolytically electronegative to aluminium. A soldered joint is therefore rapidly attacked when exposed to moisture and disintegrated. There is no solder for aluminium of which this is not true. Joints should accordingly never be made by soldering unless they are to be protected against corrosion by a paint or varnish, or unless they are quite heavy, such as repairs in castings, when corrosion and disintegration of the joint near the exposed surface would be of little consequence.

The surfaces to be soldered are carefully cleaned with a file or with emery, and are then "tinned" or coated with a layer of the solder by heating the surface and rubbing the solder into it. Solders are best applied without a flux. The composition of the solder may be varied within wide limits. It should consist of a tin base with addition of zinc or both zinc and aluminium, the chief function of which is to produce a semi-fluid mixture within the range of soldering temperatures. Tin-zinc solders may range from 15 to 50 per cent of zinc, with the remainder tin. Tin-zinc-aluminium solders may have a varying composition of zinc, 8 to 15 per cent; aluminium, 5 to 12 per cent; and the remainder tin.

The higher the temperature at which the "tinning" is done, the better the adhesion of the tinned layer. By using the higher values of the recommended zinc and aluminium percentages given, the solder will be too stiff at lower temperature to solder readily, and the workman will be obliged to use a higher temperature which secures a better joint. A perfect union between solder and aluminium is very difficult to obtain. The joint between previously tinned surfaces may be made by ordinary methods and with ordinary soft solder. Only the tinning

mixture need be special for aluminium. There is no reason why a good solder for aluminium need be brittle, as several commercial varieties are, and it is very undesirable that it should be. The tensile strength of a good aluminium solder is about 7,000 lbs. per square inch. The strength of a joint depends upon the type and upon the workmanship. Much dependence should not be placed upon the strength of a joint.

IRONCLAD SWITCHES FOR CHANGING OVER FROM CONTINUOUS TO ALTERNATING CURRENT CIRCUITS.

By J. F. Foley.

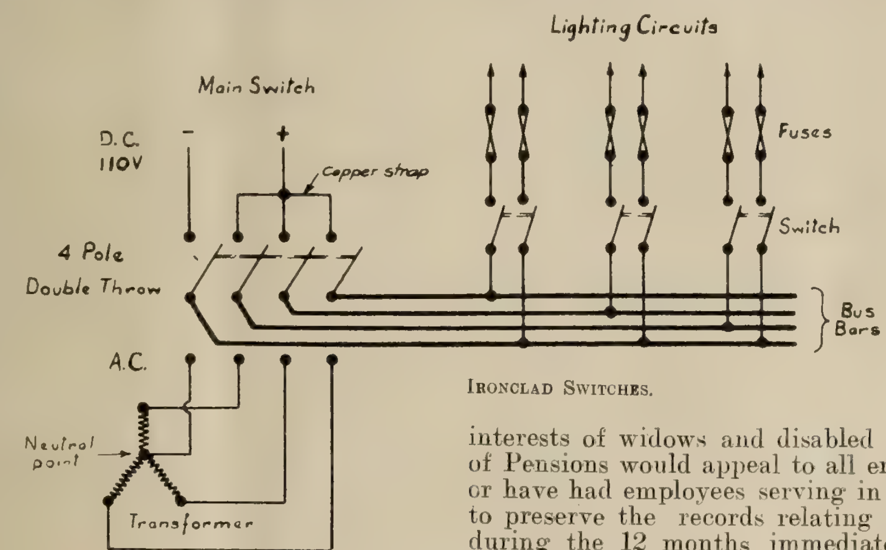
In an installation where the consumer is desirous of utilising an ironclad lighting, or small power board to work off either a continuous or alternating-current supply, it is necessary to insert a suitable control switch, and to consider the simplest way of doing this. Should the demand for this particular apparatus be great, it would obviously be essential to design a switch solely for the purpose.

The change-over switch is fitted in an ironclad case, the latter having suitable facings so as to bolt direct to the bus-bar chamber. The incoming and outgoing leads to be taken through sealing boxes or conduit, thus making a compact arrangement, and so meet Home Office requirements.

Wherever a manufacturer has already a standard 4-pole change-over switch designed, the following modification is all that is necessary to make it suitable for changing over from continuous to alternating current. A copper strap connection should be fixed across three of the contact blocks on the "D.C." side of the switch, thus short-circuiting three of the poles. The four contacts on the "A.C." side are connected to the 3-phases and the neutral point of transformer. A diagram of connections of a special 4-pole change-over switch and out-going feeder circuits is shown, which will enable the reader to follow more closely.

When the switch is inserted on the "D.C." side, it will be seen from the diagram that the current density is greater on the negative bus-bar than the positive.

The bus-bars on these small circuits are usually of ample section, for mechanical reasons, and are therefore large enough to carry the necessary current in each case. The feeder circuits may consist of a two-pole switch and fuses, or shrouded pattern Home Office fuses. Although there are few installations where a contractor may require a lighting board for working off either a continuous or alternating current supply, this scheme is worth noting.



Ironclad Switches.

MINISTRY OF PENSIONS.

Under the provisions o fthe Royal Warrant, alternative pensions may be granted to disabled men or to the widows of men who have lost their lives in the war. Alternative pensions are based upon the pre-war earnings of the sailor or soldier, and the Ministry of Pensions are experiencing considerable and increasing difficulty in verifying the average weekly earnings of an employee prior to the war, owing to the destruction in many instances of the wages books and records relating to that period. In view of increasing claims to alternative pension and in the interests of widows and disabled men, the Minister of Pensions would appeal to all employers who have or have had employees serving in the navy or army to preserve the records relating to their earnings during the 12 months immediately preceding the outbreak of war on 4th August, 1914.

HOUSEHOLD FUEL AND LIGHTING ORDER—EXEMPTION FOR DIESEL ENGINE USERS.

As a result of the representations made by the Diesel Engine Users' Association, the Coal Mines Department of the Board of Trade have now stated that they are prepared to consider applications for exemption from the operation of the Household Fuel and Lighting Order on the part of electricity undertakings using no coal for the generation of electricity.

In making application to the Department for exemption from the provisions of the Order of electricity undertakings using Diesel and semi-Diesel engines, the Association urged the importance of reducing coal consumption in this country by this means as far as possible. They also suggested that

encouragement to the greatest possible extent should be given to the utilisation of the coal reserves of the country in an economical manner by distillation of coal, which would result, not only in the home production of supplies of liquid fuel suitable for use in oil engines, but in the abstraction of various valuable products and a smokeless, solid fuel. The Diesel Engine Users' Association consider it to be contrary to the national interests at the present time that any unnecessary check should be placed on the output of electrical energy for use in connection with increased production in various industries, and they further urge that there can be no reason why consumers of electricity for either lighting, heating or power purposes should be put to inconvenience and harassed by restrictions in those areas in which the supply of electricity is not derived from the burning of coal in boiler furnaces.

CONCRETE S.S. "ARMISTICE."

The Editor of *Ferro-Concrete* sends us the following in reference to the concrete s.s. "Armistice."

We have recently had an opportunity of inspecting the "Armistice," the first British-built concrete steamship, after she had brought her first cargo to the Thames. As she lay alongside the quay in Millwall Docks, the boat presented a very fine appearance, and we were informed by the Commander, Captain T. S. Bowen, that the behaviour of the vessel had been entirely satisfactory in exceptionally heavy weather, and that there was a complete absence of the vibration so noticeable in steel vessels.

It is worthy of note that the cargo of grain brought to London amounted to over 900 tons weight, which is roughly 200 tons more than a steel ship of the same deadweight capacity would have been able to carry, the explanation of this highly gratifying result being that the interior dimensions of a concrete ship are always greater than those of a steel ship of equal weight-carrying capacity, owing to the greater weight of the structural material. Therefore, it follows that for light, bulky cargo, a concrete ship possesses decided advantages in respect of earning power.

Since her first arrival in the Thames, the "Armistice" has been carrying full cargoes between London and Antwerp, and has only lately returned from the latter port.

Built on the well-known Mouchel-Hennebique system of ferro-concrete, the vessel is owned by the Ferro-Concrete Ship Construction Co. Ltd., of Barrow-in-Furness, and is proving to be a particularly profitable investment.

GENERAL ELECTRIC COMPANY LTD.

Mr. Hugo Hirst, managing director of the above company, took the chair at the Annual General Meeting, held at Winchester House, Old Broad Street, on Wednesday, 9th July, 1919.

In a lengthy speech he expressed his views on various subjects of particular importance at the present time. Speaking of the employees who enlisted, Mr. Hirst says :—

I shall always admire their patriotism, but not their vision, since the very products that they might have stayed to produce did as much to assist in the successful prosecution of the war as the guns and shells on which they were so anxious to expend their whole energy. I refer to such things as arc-lamp carbons for searchlights, of which we were the only producers in the country. The Admiralty and War Office required not only the whole output of these works, but requested us to double them. We also manufactured trench telephone sets, trench cables and magnetos in astounding quantities. We developed and supplied wireless valves, which did so much towards bettering the communication between the Allies, and which finally helped to deal the death-blow to submarine warfare. We manufactured power plants for munition works and for warships, and special plants for the recovery of potash. Our glass works and ebonite works were at one time the only available sources of supply of certain qualities of raw materials for most important war work. It is our intention to issue shortly a brochure of all our war work, and, as we intend to forward each of you a copy, I will not keep you longer on this subject.

The war has created a new strategic position. We have to face competition from America, Japan, and other countries immensely strengthened through the war. We must also realise that Germany, assisted by the low value of the mark and by American support, may make herself seriously felt in the markets of the world, and render enormously difficult, if not impossible, the work of reconstruction which now faces this country as its most gigantic task. But I am an optimist. I believe we shall find a commonsense policy that will be supported by all responsible parties, that will enable industry not only to be regenerated, but to gain a dominant position. Our peace programme is on a large scale, because we look forward to taking part in the reconstruction of the devastated countries. There is a great lack of stocks through the world, and the immediate future must see an enormous development in everything pertaining to electricity. The demand for electrical equipment in the near future will probably be double or treble what we can produce to-day. It is for this reason that we ask for authority to increase the capital of the Company to £6,000,000.

I know there exist those who would advocate a waiting policy—to wait until labour and materials are cheaper, and until the industrial outlook is more settled, but that policy does not commend itself to me. I think, and my co-directors think, that it is our duty to assist the country in every possible way now, not only by absorbing demobilised men, but by finding employment for others. Our employees at the present moment are approaching the number of 14,000, and the programme we have embarked upon will, we hope, enable us to increase that number by an additional 8,000.

I am glad to say that the extensions which are in hand have thus far enabled us to reinstate our demobilised men without discharging and causing hardship to the other workers, but a great deal of the labour at the moment has to be retrained, and has to regain the atmosphere of the factory and office.

The measure of success we achieve will depend, in the main, on the workers themselves. We provide the most efficient organisation we can find, erect the most suitable buildings and instal the latest machinery and plant. But with largely increased wages and reduced working hours, nothing can help us and the country to increased prosperity except largely augmented output. The worker of the future will have to apply his brain more if we are to succeed in regenerating industry. Under these new conditions the worker will have to use his head as well as his hands, avoiding by every means the scrapping of materials, and deterioration of tools and plant, watching at every turn how he can improve methods of performing work, and by intensive application secure the best results from his labours. If he works in this spirit he will save heavy overhead charges, and a great number of non-productive inspectors and overseers, whose business it is to inspect, check, reject, and throw to waste finished and half-finished articles. He thus assists in creating a low-cost price—a low-cost price creates a larger market, and a larger market means more and steady employment at higher wages. We must also realise that whilst other countries have prospered during the war, and their manufacturers have extended their factories and written off their new plant and machinery out of profits, we have now to extend and rebuild at prices two or three times in excess of those prevailing before the war, and shall therefore be handicapped by having to meet heavier allocations to depreciation, as well as increased interest on capital.

My remarks do not particularly refer to our employees, but to all workers throughout the country, because we are as much, or even more, dependent on the workers in other industries than we are on our own, and any slackening on the part of coal, steel, iron, shipping, and transport workers affects us as much as if it were within our own walls.

In connection with our Birmingham works we have appointed a Director of Education, and some 300 or 400 boys are being encouraged to take up lines of study in the Company's time, which will not only fit them to perform more responsible work, but help to equip them to take a better and more effective part in the industrial struggle ahead.

A similar scheme is being started in connection with the London staff, where we have also appointed a Director of Education. Commercial apprentices from the County Council Schools and others are encouraged to benefit by the facilities which we provide.

We have also organised a special "Rush Course" for demobilised officers, particularly for those who left for the front straight from public schools or 'Varsity, and who distinguished themselves in the war, but on return found themselves without training for any trade or profession. In this way we hope to provide a reserve of competent men with character and ability, capable of filling some of the more responsible posts in the Company in all parts of the world.

I referred last year to the establishment of our Research Department, and its vital importance to the future operations of the Company in keeping it abreast and, if possible, in advance, of the electrical industries of other countries. You will be interested to learn that the principal staff of this department has been selected. The necessary buildings have not yet been provided, but are included in the programme of development.

In these days of industrial unrest, when some so-called labour leaders lose no opportunity of preaching class hatred and of misrepresenting the functions of capital, and the share which it derives from the profits of industry, it might not be out of place to point out the respective benefits accruing to capital and labour, as illustrated in our own balance-sheet. You will see that we show a trading profit of roughly £480,000, of which a sum of £255,000 is distributed by way of dividends—allowing for the income-tax on the ordinary shares. This is the return for the risks which capital has taken, risks not only of income, but of capital. Now if these shareholders had put their money into Government stock, such as War Loan, where both capital and interest are assured, they would have received about £150,000 in dividends. We have therefore a balance of £105,000, which shareholders have received for risking their capital in industry. But here is the point that I want to make. In order to earn that additional £105,000, the General Electric Company expended no less than £1,300,000 in wages, and are responsible for approximately a similar amount in contributions, taxation, and wages in other industries. Even if the whole of this sum of £105,000 were distributed amongst the workers, it would represent no more than an additional 1s. 7d. in the £ added to the wages.

It will be pointed out that there is still an unaccounted balance of £207,000 apparently in favour of the shareholders, which has been dealt with under some guise or other. How has it been dealt with? £16,799 has been paid to dependents of men on active service; £117,000 has been placed to reserve, which is an absolute necessity to enable the country to tide over periods of depression, and to ensure during such periods a continuous working of the whole machine, which in turn reflects itself to the benefit of the worker by ensuring steadier employment.

It is true that once in our history we have capitalised a proportion of our reserves, but those who have followed our development will remember that for eight years the ordinary shareholders were content with a mere 5 per cent return on their capital, in order to strengthen the Company, and we have always looked upon a part of our reserve as a means for equalising dividends.

Finally, there is a sum of £73,000 which has been placed to depreciation. There is a great misconception in many workers' minds about this item, it being held to be a means of storing up secret profits. It is nothing of the kind. I would like to interpret what I understand by the word "depreciation": "Depreciation is the gradual repayment of money spent for wages on work outside our own industry proper, so that workers within our industry can carry out their trade with the greatest comfort and efficiency."

I have addressed my remarks to the workers of the country as a whole, and not to the workers of the General Electric Company only, many of whom have for many years loyally contributed towards the success which we are now enjoying.

Our programme embodying, as it does, the doubling of our output in turbines and heavy machinery, the increase in our output of lamps, magnetos and telephones, the establishment of glass, ebonite, and other industries, cannot meet with success by the efforts of our employees only, however loyal and hardworking they may be.

We, as all other manufacturers, are dependent on the workers in other British industries for material. Our success depends upon our getting these materials promptly and of the highest standard. Ladies and gentlemen, believe me, on these essentials and on the all-important question of those materials being obtainable within the Empire, and at a price that will enable us to compete in the markets of the world, depends the supremacy of British industry, of which the General Electric Company forms an integral part. Our own success is bound up with its ascendancy—let us work for it wholeheartedly.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.

West Midlands Branch.

The quarterly meeting of this Branch was held at the Imperial Hotel, Birmingham, on July 11th. In the President's absence, Mr. F. H. Boden, the Vice-President, opened the meeting at 7-45 p.m. A salary-averaging scheme was introduced by Mr. Boden, but owing to the small attendance, it hardly met with the success anticipated, and may possibly be put forward again at the next meeting.

Mr. F. H. Rigby appealed to the meeting to financially support the resolutions passed at the last meeting *re* levy for Branch Headquarters and Secretary's Honorarium funds, in order to complete the equipment of offices at 78, High Street, Birmingham. Suggestions were made regarding the use of the offices as a technical library, etc., and it was pointed out that this could only be done by financing the scheme already formulated. He trusted the correspondents and members present would do their utmost to push this in their respective offices.

Mr. W. Pitt drew attention to the papers to be issued by Headquarters, the sale of which would assist the technical section of the Branch. He had already had three promises from prominent gentlemen to give papers, and would also try to arrange visits to several works during the forthcoming winter.

Mr. George V. W. Darby, the Hon. Secretary, gave his report, which covered the following items: Election of officers for various duties, trade disputes, duties of correspondents, propaganda, amalgamation, affiliation to Trades and Labour Council, literature, Dudley Sub-Branch, office committee, referendum on policy, control scheme, and apprentices. A typewritten report of the Conference having been circulated to all office correspondents prior to the meeting, it was agreed that it was unnecessary to read this out. The resolution appertaining to the increased subscription was unanimously endorsed.

The meeting was brought to a satisfactory close at 9-45 p.m.

Altrincham Branch.

By the kind permission of the Partington Steel and Iron Co. Ltd., the members of the Altrincham Branch of the Association of Engineering and Shipbuilding Draughtsmen were allowed an opportunity of visiting their works on the evening of July 11th. Great interest was evinced when ingots were passed through the large rolling mills. The ingots having been rolled out into small rectangular sections, were passed on along the rollers to a saw—swung pendulum-wise—and were cut off into predetermined and uniform lengths. The party, which was divided into three sections, was conducted round the works by Messrs. Williams, Oakley and Chasser, who explained the various processes in a most thorough and instructive manner.

W. Gerrard, Chairman of the Technical Committee.

Publications.

Grits and Grinds for July (the journal published by the Norton Company, Worcester, Mass., U.S.A.), contains the second instalment of "Grinding Manganese Steel Castings," the article we spoke of in our last issue. The grinding of a 16-inch herringbone mill pinion; a 72-inch lathe, equipped with special fixture for cylindrical grinding; and a boring adapted to surface and internal grinding is described and illustrated. An interesting article also appears in this number on "Tests for the Strength of Protection Hoods," by A. Rosseau.

Cheap Steam for July (an interesting journal published by

Messrs. Ed. Bennis and Co. Ltd., 28, Victoria Street, S.W. 1), is devoted to efficient and economical boiler-house practice. The purpose of the magazine is to provide a forum for the free and frank discussion of problems connected with boiler-house management. The chief feature in this issue is an argument on the calorimetry of coal (by permission of the Editor of *Engineering*).

New Companies Registered.

Hatcham Manufacturing Co. Ltd. (156,393).—Private company. Registered June 24th. Capital, £3,000, £1 shares. To take over the business of electrical and general engineers carried on by A. S. King, E. A. Endacott, and F. W. Carpenter, etc. First directors: A. S. King, E. A. Endacott, and F. W. Carpenter. Office: 314, Gray's Inn Road, W.C.

Norman Engineering Co. Ltd. (156,633).—Private company. Registered July 2nd. Capital £5,000, £1 shares. As title. First directors: A. Matthews and F. Baron. Solicitors: R. A. Rotherham and Co., 38, Bailey Lane, Coventry.

Prescot Engineering Co. Ltd. (156,521).—Private company. Registered July 2.8 Capital, £5,000, £1 shares. As title. First directors: A. Matthews and F. Baron. Solicitors: R. A. Rotherham and Co., 38, Bailey Lane, Coventry.

Prescot Engineering Co. Ltd. (156,521).—Private company. Registered June 28th. Capital £1,000, £1 shares. Mechanical engineers, etc. First directors: J. J. Haydon and A. Bennison. Office: Cross Street, Prescot.

Henry Gardner and Co. Ltd (156,938).—Registered July 11th. Capital £1,000,000, £1 shares. To acquire the business and all or any of the assets of the firm of Henry Gardner, and to carry on in the United Kingdom or elsewhere, as principals or on behalf of others, the business of smelters, rollers, refiners and manufacturers of and dealers in metals, ores and metallic and mineral substances, etc. The subscribers are: Henry Gardner, Walter Gardner, Wm. R. Phinn, Frank V. Angell, Frank L. Niskin, Mm. S. Loftus and W. Bevan. Minimum cash subscription, 7 shares. The subscribers are to appoint the first directors. Registered office: 2, Metal Exchange Buildings, E.C.

Tri-Ed Engineering and Motor Co. Ltd. (156,763).—Private company. Registered July 5th. Capital £5,000, in 4,950 preference shares of £1 each and 1,000 ordinary shares of 1s. each. To take over the business of general and motor engineers carried on by R. D. Milne, S. H. Bowles, and G. E. A. Brown at Bridge Road Works, Edmonton, as the "Tri-Ed Engineering Co." Directors: R. D. Milne, G. E. A. Brown and E. J. Heraud. Office: 599, High Road, Tottenham.

Marseel Engineering Co. Ltd. (156,798).—Private company. Registered July 7th. Capital £2,000, £1 shares. Manufacturers of motor cars, motor cycles, etc. First directors: D. M. K. Marendaz and C. H. Seelhoff. Solicitors: Browetts, 23, Bayley Lane, Coventry.

James Motor Engineering Co. Ltd. (156,533).—Private company. Registered June 30th. Capital £5,000, £1 shares. Motor and general engineers, etc. First directors: W. H. James, B. W. F. Whittaker, 191, Wolverhampton Street, Dudley, and A. Hibbert.

South London Motor Works and Garage Co. Ltd. (156,736).—Private company. Registered July 4th. Capital £15,000, £1 shares. Manufacturers of and dealers in automobiles, aeroplanes, etc. First directors: W. G. Allen, M. Evans, A. Slagg, E. Evans, A. Keirle and G. Everden. Office: 105a, Nightingale Lane, Balham, S.W. 12.

This Year's Machinery Exhibition at Olympia.—The Shipping, Engineering, and Machinery Exhibition which was to have been held in the autumn of 1914, but was postponed because of the war, will be opened at Olympia, on September 25th, by Lord Weir, of Eastwood. Mr. F. W. Bridges is secretary and organising manager of the Exhibition, which is to remain open for three weeks. An official bulletin and prospectus that has been issued, includes a list of the exhibitors. Quite a number of electrical and allied manufacturers appear therein. We understand that all space on the ground floor has been taken, and the gallery spaces are nearly all occupied. The Exhibition offices are at 124, Holborn, W.C.

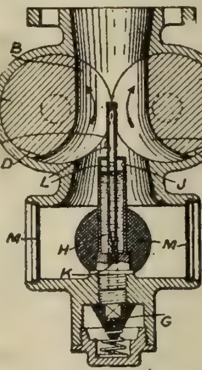
Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

INTERNAL-COMBUSTION ENGINES.

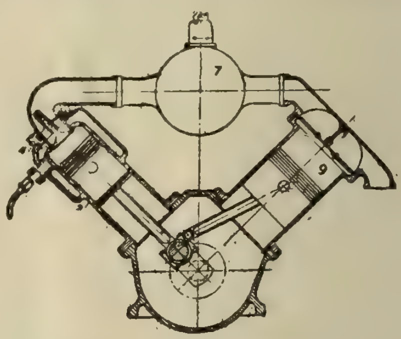
120,461.—G. G. Dawson, 14, Highland Road, Upper Norwood, London.—April 18th, 1918.—The passage around the nozzle E of a spray carburettor is formed by tapered grooves B formed in the peripheries of two barrels A geared together so as to move



simultaneously in opposite directions. The barrels are cut away at D to clear the nozzle when the air passage is closed. The nozzle comprises a tube E with orifices at the top and at L, L and is surrounded by a concentric auxiliary nozzle with orifices at J. The main spraying-tube E has a constriction at K which prevents the mixture from becoming excessively rich in fuel at high speeds. The fuel is filtered at G and the air by screens at M.

INTERNAL-COMBUSTION ENGINES.

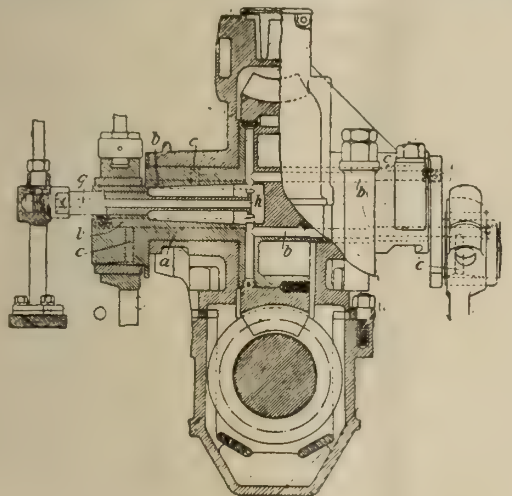
120,480.—Boulton and Paul, Aircraft Works, Norwich, and J. D. North, The Cottage, Burgh Apton, Norfolk.—Dec. 29th, 1917.—Aero-engines are supplied with air at an approximately uniform



pressure at all altitudes by compressing it by the pump 9 into a reservoir 7 with a spring-loaded escape valve whence it flows into the engine through a beat valve 4 when the piston uncovers the exhaust ports 2.

LUBRICATING.

120,505.—W. E. SAVERY, Ivy Bank, Middleton Hall Road, King's Norton, Birmingham.—March 2nd, 1918.—To lubricate the parts of air and circulating pumps employed in small marine engines, a stationary oil pipe *g* inserted in a hollow driving-



shaft *a*, terminates in a drip flange *h* which delivers oil to a number of radial and longitudinal passages *c*, *b* in the shaft leading to the various bearings. The lubrication continues irrespective of tilting of the shaft.

VARIABLE-SPEED AND REVERSING GEARING.

120,506.—J. RUSCOE AND CO., and G. H. KENYON, Albion Works, Hyde, Lancashire.—March 6th, 1918.—In the form shown in Fig. 1, planet pinions *d*, carried by the driving-shaft *a*, gear with a sun-wheel *f* fixed on the driven shaft *b* and with a sun-wheel *e* loose on the shaft *a*. The wheel *e* is driven at a variable speed from the shaft *a* through gear-wheels *q*, *p*, a friction disc *m*, and spring-pressed friction discs *j*, *k*. The discs *j*, *k* are carried

FIG. 1.

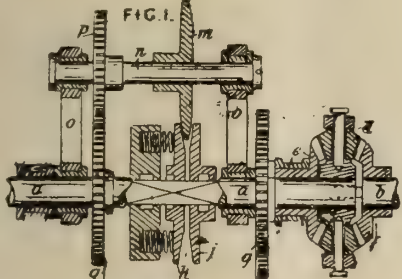
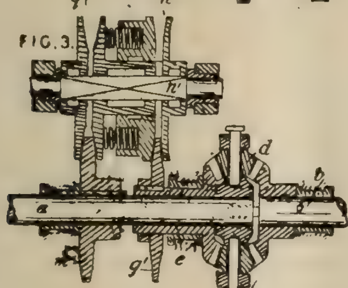


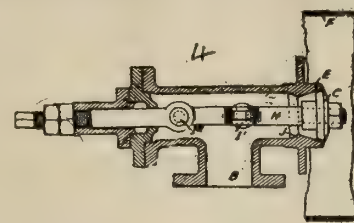
FIG. 3.



by an auxiliary shaft geared to the pinon *g* attached to the sun-wheel *e*, and the shaft *n* is mounted on arms *o* to enable the disc *m* to be brought into variable engagement with the discs *j*, *k*. In the modification shown in Fig. 3, a friction disk, *m*1, on the driving-shaft *a*, drives the sun-wheel *e* through two pairs of friction disks on a shaft *n*1 and a friction disk *g*1, and the shaft *n*1 is mounted in pivoted arms to enable the disks to be brought into variable engagement.

EJECTORS.

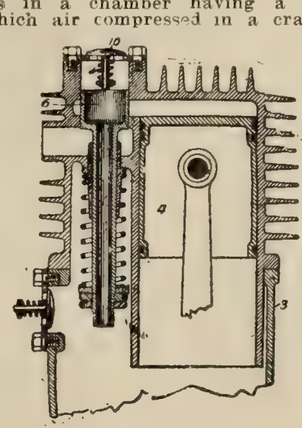
120,516.—H. E. YARROW, Yarrow and Co., Scotstoun, near Glasgow.—May 2nd, 1918.—Relates to systems for ejecting waste gases from marine furnaces through ducts leading to the vessel's side or stern, for the purpose of diminishing visibility, and consists in improved means for centring within these ducts the valves whereby water is introduced in the form of a conical spray to induce a draught. In order that the water entering at the inlet B may cause the valve C, between which and the seating E the water passes into the duct F as a conical spray to maintain itself accurately centred, the valve is carried by a spinde H having free joints I1, I2 at right-angles. The water passes through a restricted passage J before reaching the valve, and the opening of the valve may be adjusted by means of the screw-threaded mounting of the spindle H. Alternatively, the



spindle H is without joints and is reduced in diameter sufficiently to have the flexibility necessary for automatic centring.

INTERNAL-COMBUSTION ENGINES.

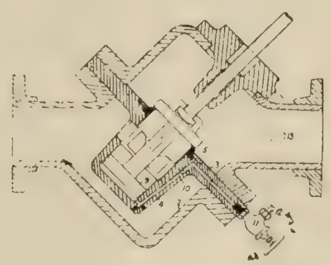
120,510.—C. H. INGOLL, 10, Palmerston Road, Coventry.—March 14th, 1918.—Beat or piston valves are cooled by circulating through them air which is compressed in the crank case. In the construction shown in Fig. 1, a piston valve 6 having a hollow stem reciprocates in a chamber having a non-return valve at 10 through which air compressed in a crank chamber 3 is



discharged during the down-strokes of the piston 4. If preferred the valve 10 may be dispensed with, air being drawn into, and discharged from, the crank chamber through the hollow valve stem. A modified construction is described in which the piston valve shown is replaced by a beat valve. In both constructions, lubrication is effected by oil picked up by the cooling-air.

VALVES.

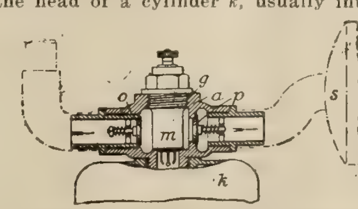
120,525.—BABCOCK AND WILCOX and A. SPYER, 30, Farringdon Street, London.—May 22nd, 1918.—A valve casing made of two steel stampings 1, 2 having inclined ends so that it may be assembled as a straightway or right-angle valve has a partition 3 clamped



between the two parts which partition carries the valve seat 5 and the cylinder 4 for the balancing piston 9. The lower side of the piston is connected through a duct 10, valve 11, and pipe 12 to the main passage 13.

INTERNAL-COMBUSTION ENGINES.

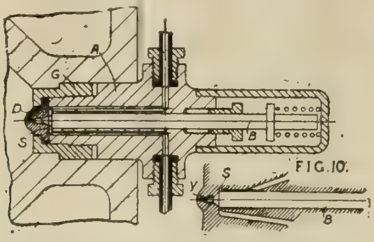
120,601.—W. G. RITCHIE, 110, Cannon Street, London.—Nov. 7th 1917.—A **T**-shaped pipe *a* containing non-return valves *o*, *p*, is screwed into the head of a cylinder *k*, usually into the sparking-



plug socket, to enable the cylinder to be used to compress combustible gas into a reservoir *s*. The fitting is closed to the cylinder when not in use by the sparking-plug *m*, but when it is in use the sparking-plug is replaced by a plain plug which merely closes the orifice *g*.

INTERNAL-COMBUSTION ENGINES.

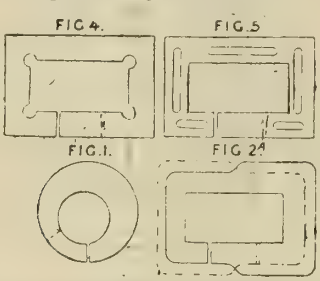
120,609.—Sir K. I. Crossley and W. Le P. Webb, Crossley Bros., Openshaw, Machester.—Nov. 10th, 1917. Nozzles from which issue in succession a light igniting fuel and a heavy fuel without spraying air are provided with a small cavity S around the valve B near its seating for the reception of the igniting fuel which,



on entering, displaces the column of heavy fuel extending into the cavity when the valve is closed. The fuel passages are made by drilling the valve casing or grooving the valve spindle, its guide, or casing. The nozzle D is secured to the casing A by a screwed cap G. The valve may be opened by fluid pressure or mechanically, and its end may be extended as shown at Y, Fig. 10, into the cavity of the nozzle beyond the seating.

DYNAMO-ELECTRIC MACHINES.

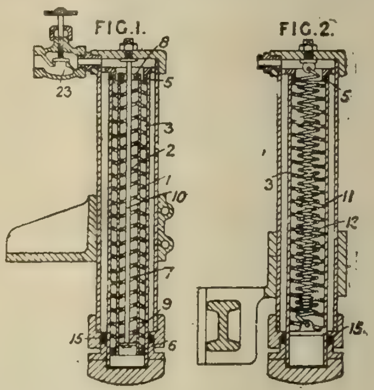
120,593.—Lancashire Dynamo and Motor Co., Trafford Park, Manchester, and H. B. Whitmore, Brereton Cottage, Bramhall Lane, near Stockport, Cheshire.—Oct. 8th, 1917.—Relates to coil windings for the magnets of dynamo-electric machines of the type



in which the coil is made from a number of stampings of flat sheet metal or the like which are fitted together to form a coil, and consists in so forming the stampings as to facilitate ventilation and cooling of the coil. For this purpose, the stampings may be formed with the outer contour eccentric with respect to the inner contour as shown in Figs. 1 and 2*a*, so that when the stampings are assembled with their ends overlapping as indicated by the dotted lines, succesive stampings will project at different portions of the circumference of the coil and produce projecting flanges giving increased cooling surface. Alternatively slots may be formed in the body of the stamping as shown in Fig. 5, or notches may be formed on the inner contour, as shown in Fig. 4, so as to form ventilating passages through the substance of the coil, or between the coil and the core. Each stamping may completely surround the core, as in the forms shown, or each turn may be built up of two or four pieces, metal being thus saved in the stamping. A method is described of forming the stampings with lugs to provide terminals.

LIFTING-JACKS.

120,637.—E. Graham, Dunottar, King's Road, Knock, and G. Bowman, Ballygomartin Road, both in Belfast.—Nov. 13th, 1917.—The ram of a fluid-pressure-actuated jack for motor, etc., vehicles is returned when the pressure is withdrawn by a plurality of springs. The ram 3, Fig. 1, contains two compression springs 1. 2 separated by a sleeve 7. The spring 2 bears against a plate 9 carried by a rod 10 secured to the top of the jack, and against a ring 8 at the top of the sleeve 7. The spring



1 bears against a flange 6 on the sleeve 7 and a ring 5 on the ram 3. In a modification, the ram 3 contains a compression spring 11, Fig. 2, and a tension spring 13. The packing-gland 15 is secured to the end of the jack casing and bears on the outer wall of the ram below or beyond the end of the casing. A valve 23 is provided on the pressure supply pipe for shutting off the pressure supply and at the same time maintaining the pressure in the jack when it is desired to leave the jack with the ram extended.

INDEX TO ADVERTISERS.

[*When enquiring of Advertisers will readers kindly make a "special point" of mentioning* The Industrial Engineer.]

— THE —

Industrial Engineer.

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The Industrial Engineer.

A PRACTICAL MAGAZINE FOR ENGINEERS AND POWER USERS.

Published twice monthly, on the 8th and 22nd days, respectively.

All communications intended for insertion in the* INDUSTRIAL ENGINEER, *or relating to Editorial matters, should be sent addressed to " The Editor," at our Office,* 121, *DEANSGATE, MANCHESTER, and must be accompanied by the name and address of the writer. Anonymous letters will not be noticed. We cannot undertake to return manuscripts or drawings, and correspondents are warned to keep copies.

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EDITORIAL.

THE WAGES OF SKILL.

THE reward of work is commonly termed wages or salary, the distinction being less one of period fixed than one of idea. Profits and wages have this in common ; they are proportionate to volume of work, at least such is their theory. The worker is remunerated upon a time or piece basis, and profits are a percentage of total turnover. Ordinarily the salariat receives no exact extra recompense for additional time, while proletariat wages are in strict ratio either to time worked or output achieved.

Profits are, of course, affected by many outside factors, while the rate of wages remains a fixed quantity. Economists use the term wage fund to express one industrial conception, just as they separate profits from interest on capital and the reward due to business ability.

The incentive to effort of capital for which it takes risk and outlay is profit, whose magnitude is the direct incentive to enterprise. Labour is usually uninterested in the complete industrial equation but desires a fixed and generous individual recompense.

Rate of wages is the outcome of a compromise which the employer terms market rate. He is usually indisposed to pay more than he is compelled, and indeed his business, if competitive, must be on a basis of equity as to the amount produced in terms of outlay.

To defeat inferior conditions labour federates and combines to enforce a minimum wage. Capital combines and federates for many reasons, one of which is a similar collective action to make rates of pay uniform. The interaction of these oppositions has hitherto made current wages.

Athwart this condition and in amelioration thereof is the establishment of the Whitley Scheme to federate industry as a whole, both masters and men. The more highly skilled the worker the better he is organised, and it is only recently that less skilled labour has combined. Former combination, led to the highly skilled penalising the more inferior labour by raising the price of necessities to all alike. Latterly the cost of living has been a determinant factor in settling current rates.

Pursuing organisation to its logical outcome whereby everyone is in combination and interlinked together, in the place of sectional labour troubles, a national identity by class appears. Should the complete federation demand inordinate reward on the basis of an infinitesimal working day, nominally its members could enforce their wishes to their own undoing.

It is practically at this point when the nation is one vast trades union that industrial legislation by industry has become imperative, and a national conference is to determine the issues.

Present rates of pay are largely artificial and the result of organised demand rather than proportionate to ability, training or competence. The working day is conditioned by production per unit of time, nominal rates of pay in currency symbols matter little or nothing, it is purchasing power which determines recompense.

To produce merely what the individual consumes is in reality dire poverty, for no surplus exists for the finer things of life nor for the construction of large schemes of public utility. It is perhaps the outstanding defence of capital that it has in the past, enabled railways, bridges, water supplies, and other amenities to be constructed in addition to the exploitation of Nature's stored wealth. In addition, to make capital remunerative to its possessor, it must be beneficially employed ; the great condemnation of luxury is that it cannot be reproductive.

The greatest factor in wealth production is mind, for without intelligence man could never have achieved civilisation at all. Labour has its importance, but skill, mentality, acumen are even more necessary. Without labour all would be a wilderness; without mind the conditions of life would be drastic severe and onerous, it is the application of intelligence which has allowed human development.

Present anomalies are numerous enough. Under the present system of unscientific rewards to skill, muscle alone receives remuneration out of all proportion to superior mentality. Until altruism becomes the ruling human motive, the premium placed on muscle as against arduous mental toil and long training gives no incentive to the acquisition of knowledge. If mental effort is to be less rewarded than physical power the man directed is socially superior to those who find the direction.

Somewhere between the upper and the nether millstone lie the salariat, whose reward is much too dependent upon caprice and favour; possibly they have their own superior attitude to thank, but the position is unenviable all the same. It is very largely this class to whom capital looks for directing ability, and upon whom labour is dependent for its reward.

In the main, the alleged law of supply and demand is operative; the point at issue at the moment is that if the reward for high training is too small, there is no incentive for its acquisition.

Failing that counsel of imperfection, which would reward all men equally, under which those who helped the executive would most probably help themselves, and leaving aside scarcity as the only criterion of value, is it possible to consider real value upon an equitable basis?

In many industrial connections there are basis rates to which are added various extras; any controlled scheme of prices will serve. The plain material is at any instant of time fixed, while market value rises and falls; subsequent manipulation and work done are classified as additional percentages or excess amounts on the basis price. It is admitted that an application to human valuation is perhaps difficult, but the smallest sum upon which an adult individual can maintain himself would be the basis rate. The hypothetical casual labourer representing muscle without intelligence would seem typical. Under strictly commercial and economic conditions such a rate did obtain. Above this comes an infinite series of graduations needing dispassionate assessment before a tribunal of skill. Apart from skill value, there are two other considerations; in addition to a wage of skill there might be additions termed wages of service and wages of character. To some extent these are already operative, but depend upon stationary location of the individual to a large extent.

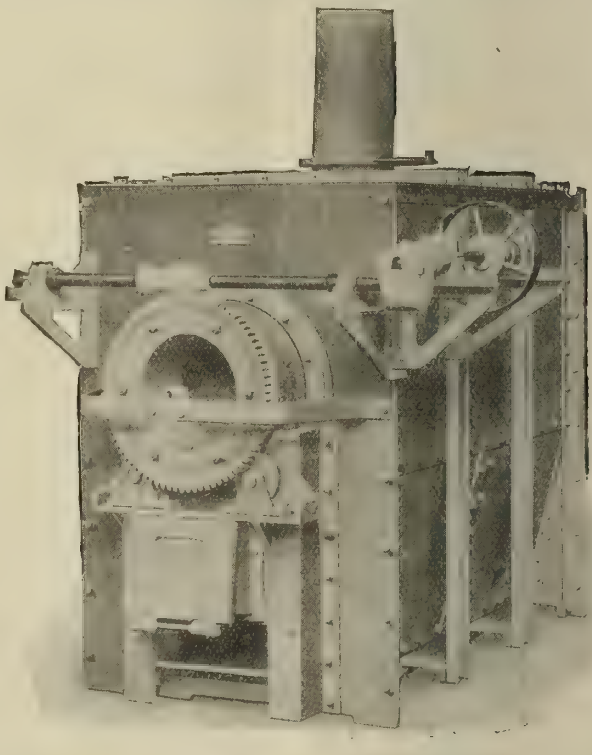
The troubles of such assessment are nearly as numerous as the gradations it would endeavour to fix, for value is dependent upon many intangibilities other than simple knowledge. It should not, however, be impossible in some broad and general manner to grade ability and award classification. One of its drawbacks is that it would establish caste, but to a very great extent that is already more or less in operation. One of the most striking features of the present time is that there is great transvaluation of value; matters of pre-war pride are matters for after-war regret.

Lending rein to the imagination, the tribunal is set up, technical assessors assist the judiciary; and for the first time in history real value is to be determined. The major and minor salariat are tried for competence and real utility. There would be many inversions of personal belief; and it would, perhaps, granted real competence on the part of the judge, be a veritable day of judgment. Simple cunning would get short shrift, and perchance honest men come into their own. Possibly the working of economic forces and the readjustment current, however imperfect it may be, would be preferable to the fierce light which searched record, character, and value. The general idea is not without interest, but upon reflection in an imperfect world, so logical a method is self-condemnatory. However this may be, there is value in skill, judgment in experience, worth in character.

NATURAL DRAUGHT ROTARY CARBURISING FURNACE.

[THE RICHMOND GAS STOVE AND METER CO. LTD., WARRINGTON.]

WE have received a description of the above-named furnace, for which it is claimed that the output of work that can be carburised in the No. 3 size is 15 to 20



RICHMOND CARBURISING FURNACE.

cents per day of 24 hours at the rate of four to five cents per charge. Two other sizes of furnaces are also now constructed to take one cent and two cents at one charge. Labour costs are said to be reduced, the output per man being 271 lbs., while the fuel costs are less than one-half those of ordinary brick-built furnaces output for output. The following is a description of this furnace:—

The process was devised primarily for the carburisation of small work of uniform size and character, but some idea of its applicability may be

gathered from the fact that furnaces have been supplied for work ranging from needles to roller-bearing rings of 7½ in. diameter.

The system is one which possesses features of exceptional interest, not only from the standpoint of economical working, but also from the method in which the carburising medium is supplied. The process is carried out in a specially constructed furnace, and differs substantially from standard practice in that:—

(1) The work under treatment is constantly agitated.

(2) No packing in pots or boxes is necessary.

(3) The carburising gas is retained under pressure

By this process the work to be carburised in bulk is mixed with the special carburising compound in the proportion of only 10 per cent to 12 per cent by weight, according to depth of "case" required, and the whole loaded into the muffle—an operation so simple that it may be done with a shovel—and the sealing door immediately clamped up.

The muffle is then rotated by mechanical means for a sufficient length of time to obtain the desired depth of cementation. As, however, the compound gives off a profuse supply of carburising gas, and the muffle being well sealed, the penetration is rapid. Assimilation is accelerated by a pressure of several pounds to the square inch. By the employment of pressure as well as movement the interior of the retort under this system is filled with a gas of uniform composition throughout, so that uniformity in both depth of penetration and percentage of carbon absorbed is assured, irrespective of the shape of the pieces of work under treatment.

The operation of heat treatment after carburising is exactly similar, except that in this case the work is mixed with only about 1 per cent or 2 per cent of carburising compound before being heated to the temperature required for the particular steel under treatment. The object of heating in the presence of carburising compound is that a proper atmosphere may be created and de-carburisation made possible.

OIL SHALES.

(*Continued from page 409.*)

In order that the subject of oil-shale may be rightly understood, it is essential to have a clear idea of the difference between an oil-shale and an oil sand. The petroleum of to-day is coming largely from oil sands, but it may not be amiss to prophesy that it will not be many years before oil-shales will furnish oil in large quantity. An oil sand is more or less porous rock between the grains of which the oil is entrapped, and from which the oil may be extracted by solvents or mechanical means, or from which oil will flow when the sand is penetrated with the drill. Oil-shale, on the other hand, is a very fine-grained and compact rock which contains practically no free oil, but which does contain an abundance of partly decayed and bituminised organic matter from which oil can be manufactured by simple distillation processes.

Practically all oil-shale is tough and hard to break, and some of the thin-bedded varieties are remarkably flexible. All oil-shale is thin-bedded, although some of the beds weather into massive ledges, in which case the thin-bedded character is evident only after the shale has been heated and the oil driven off. On the exposed surfaces oil-shale weathers to a bluish-white colour, but the weathered surface is only skin deep, so to speak, for usually within less than an inch from the outside, the shale is unaffected, and has the characteristic dark-brown or black colour; the darker the colour the richer the shale. When freshly broken, oil-shale gives off an unmistakable odour of petroleum, but this quickly vanishes, so that within a few minutes after the rock is broken the asphalty odour has entirely disappeared. Many of the richest shales of the Green River formation of Colorado, Utah, and Wyoming have a peculiarly waxy, or velvety lustre, and resemble in a way cannel coal. Still other and equally rich shales are dark-brown, and in the case of the rich oil-shale from near Elko, Nev., the rock is yellowish-brown and lustreless. Most of the oil-shale beds are composed of alternating dark and light coloured laminæ, with the relative richness of the bed depending on the preponderance of the darker-coloured material. Good oil-shale will burn with a sooty, yellow flame when it is ignited with a match. In the region where the oil-shales outcrop, campers and cow men very often use the shale for fuel in their camp fires, and in some places I have even seen the rock used in the stoves. This latter use, however, is not very satisfactory on account of the great amount of ash which oil-shale contains. Late in the fall of 1918 my little party was working near the great cliffs of oil-shale in north-western Colorado when much to our dissatisfaction the weatherman decided to give us a week of rain, and as a result everything, even the firewood, was wet, and there was no coal within 25 miles. A happy thought, and after a little coaxing, a fire was kindled and blocks of oil-shale which lay all around on the ground were piled over it. Very soon we had a rousing fire, even if it was sooty, and those rocks burned furiously for at least three hours, and in the end the camp washing was done.

Valleys near the outcrop of the oil-shale are always strewn with the boulders of shale which have been broken from the ledges at the outcrop, and in many places these large angular pieces have been carried miles from their original resting place without disintegrating in the least, for weather has very little effect upon the oil-shale. The story is often told in the shale regions how a certain rancher built a new cabin and made the fireplace and chimney out of the blocks of shale which he found strewn about over his fields. The very first time that he made a fire in the fireplace his house was destroyed, and not even the chimney was left standing, for that, too, burned, and there remained only a bed of soft ashes after the flames had been quenched.

Oil shale is much lighter in weight than coal, and the lighter it is the more oil can be distilled from it. Coal with an ash content of 10 per cent is considered pretty poor fuel, but the oil-shale which I just described burns furiously when once started, and yet has 50 to 70 per cent of ash, and therefore could not be used as fuel satisfactorily.

The Green River formation contains the richest and most extensive beds of oil-shale known, but not the whole formation is oil-yielding. Rich oil-shale is interbedded with lean or barren shale, or in a

few places with oölite and sandstone, and because of its resistance to the weathering agencies, beds of rich oil-shale ordinarily project beyond the rest of the rocks which are present in the cliffs. Along the south side of the great Uinta Basin in Colorado and Utah for a distance of 150 miles or more there are beds of oil-shale thick enough to mine and rich enough to warrant the establishment of an industry of immense proportions; in fact, nearly 4,000,000 acres in this region have been classified by the Government as land valuable for its oil-shale. The greatest thickness of rich oil-shale beds is in the eastern third of this great area, and in part of the field near De Beque and Grand Valley, Colo., and Watson, Utah, there are beds of rich shale aggregating more than a hundred feet, and much of this shale is capable of yielding more than a barrel of oil to the ton of shale.

Oil-shale beds in most places lie nearly horizontal, much as the coal beds in the western part of Pennsylvania, but different from the coal in that oil-shale beds outcrop high up on the sides of great mesas 2,000 to 3,000 feet above the valleys. Because of this, when our engineers begin to work the shales they will have to instal long and expensive tramways to bring the shale down to the elevation of the distillation works, which will necessarily be located in the valleys near water and transportation.

The shales of the Green river formation were all laid down in fresh water lakes in which grew great masses of vegetation and into which the pollen and leaves of the higher plants were washed and blown by the winds. Large numbers of insects swarmed the air in those days and their bodies were buried in the slimes and mud at the bottom of the lakes, and these shale beds now contain an abundance of excellently preserved fossils. During the last two field seasons considerable time has been spent studying these records of the life that thrived when our oil-shales were being made. The fossil collections now include beautifully preserved beetles, flies, mosquitoes, bees, leaves of all kinds, fish skeletons, and even bird bones. And in addition to these fossils which are visible to the naked eye, the miscroscope brings to light an immense variety of tiny organisms, many of which are easily identified but others of which are as yet not understood. The richer oil-shales contain an abundance of vegetable material, including such types as ferns, fungi, bacteria, algæ, and pollen, perhaps the most remarkable of these being the algæ. It is difficult to imagine under what conditions such delicate forms as the water trough slimes could be imbedded in mud and then the mud become hardened to the tough shale as we find it to-day and still have the cellular form of these soft plants preserved. This is one of the wonders of oil-shale. The immense amount of organic material in the rich oil-shale and the relative absence of such material in the leaner shales may be a mere coincidence, but when it is realised that it is practically impossible to extract any oil from even the richest shale by any means except heat, then it seems that the oil must be made by the destructive distillation of the organic material, and that in all probability the larger part of the oil comes from the vegetable matter in the shale, and perhaps most of it from the lower forms of vegetation such as the algæ.

(To be continued.)

OLEIC ACID FLUX—ITS STRUCTURE AND HABITS.

Written and Illustrated by James Scott.

Many of the minor operations connected with industrial work are of greater importance than is generally credited to them. They may be practised systematically according to long custom in a particular direction, simply because they have been found, by continual experience, to produce desirable results. The effects procured from them are accepted as satisfactory, without troubling to probe into the reasons for their production. There is now, however, a stimulation of enquiry into several processes of a kind seldom before attempted, and the results of the scattered experiments and tests, when gathered together, will no doubt yield considerable useful information.

As an instance of what is referred to we may take the fluxes. These accessories to the easy manipulation of the metals concerned have been adopted by artisans from time immemorial, without much real investigation into their routine conduct having been undertaken.

In the blast and other furnaces fluxes of limestone, fluor spar, etc., are introduced to combine with the oxygen and associated gases which are liberated from the iron oxide, or iron carbonate, ores during their melting, and they, in conjunction with various earthy matters, comprise the well-known slags.

In casting molten metal, more especially when these are prepared from scrap, fluxes are also necessary, as was emphasied in *The Industrial Engineer* a few months ago by Captain A. E. Plant, A.S.C., in his interesting article on "The Use of Oil Fuel in the Foundry in Urgent, Exceptional Circumstances." In the melting of ingots in crucibles, etc., preparatory to pouring into moulds, it is required.

The natural sluggishness of the metal is overcome in this manner; and it is rendered tolerably fluid.

In soldering, brazing, welding, and so on, fluxes of definite nature are needed to prevent the promotion of defective joints. In all these cases, whatever may be the actual constitution of the flux, the object is the same, namely, the absorption of existing and evolved gases and impurities by the flux, so that the metal shall be freed from their injurious presence. Otherwise, the metals, after having cooled and solidified, would be occupied by particles of various foreign matters, such as dross or oxide, due to the combination of oxygen and metal, besides tiny blowholes and analogous features.

As the writer previously mentioned says:—

"It is necessary to use plenty of flux to protect the surface of the molten metal from absorbing gases."

It should be understood that it is not an incident of simple greasing of the metal, as follows the lubrication of metal fittings, when the principal action of the oily material is to attract frictional heat and disperse it before it can do any mischief. In fluxing we have to consider the proximity of heated air, flame, dust, grit, and so forth, the products of which, by getting locked up in joints (unless provision is made to guard against that mishap), actually cause the development of compounds and mixtures of a very weak character, which make the subse-

quently cold metal hard, unyielding, and brittle; and, maybe, in unforseen circumstances, absolutely useless.

On the present occasion I must confine my attention to oleic acid flux, taking as an excellent representative of this class a product which has been of extremely widespread utility during the war, and will undoubtedly continue its high degree of service in peace time. It is prepared by the Hillcrest Oil Co. (Bradford) Ltd., Victoria Works, Clayton, Manchester. Although it has nothing attractive in its appearance—indeed, it is uninviting in this rspect, and has a somewhat unpleasant odour—its fluxing powers are of the utmost possible efficiency. The manufacturers tell me that (to quote from their letter): "This is the grade which has been supplied by us in large quantities for fluxing shells, etc."

They point out that it contains a fairly high percentage of fatty acids, calculated as "Oleic." This statement induces me to describe, in a brief manner, the genral constitution of common fats.

Beef, mutton, lard, and similar animal fats, when

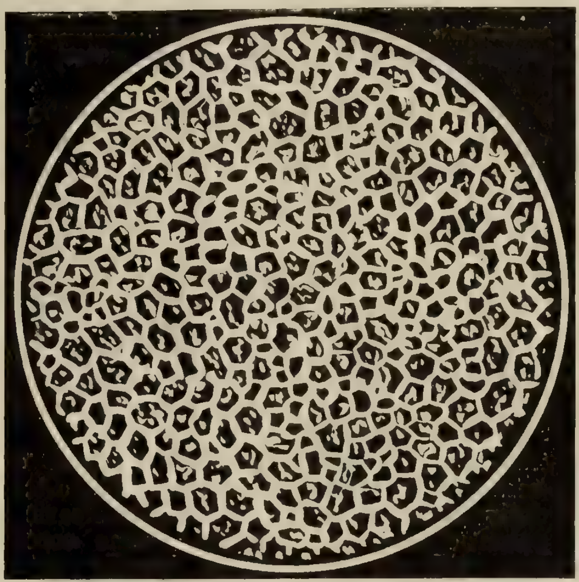
No. 1.—One twenty-fourth inch portion of a layer of fluxing oleic acid changing from the melted to the solid state (magnified).

boiled with an alkali—*i.e.*, caustic soda or potash—yield soaps, and at the same time, crude glycerine is separated from them. For this reason they are known as glycerides. When fresh, they consist of compounds of stearin, palmitin, and olein in varying proportions, the denser ones having more of the first two ingredients, and the softer ones more of the last-named. Stearin is composed of stearic acid (a wax or fatty acid) and glycerin; palmitin is composed of palmitic acid (a wax, or fatty acid) and glycerin; and olein is composed of oleic acid (a viscid oil, or fatty acid) and glycerin.

Many vegetable oils, such as palm oil and olive oil, contain these glycerides. In fact, their names have given rise to those of the fats referred to—palmitin and olein, for instance.

There is no need, however, to go deeper into this phase of the subject, because one seldom finds, in commerce, the absolutely refined substances like those obtained in the laboratory after the performance of skilful experiments. The technical chemist speaks of tri-stearin, tri-palmitin, and tri-olein; but we are not called upon to do so. What we have to realise is that after fluxing processes oleic acid is practically a waste material.

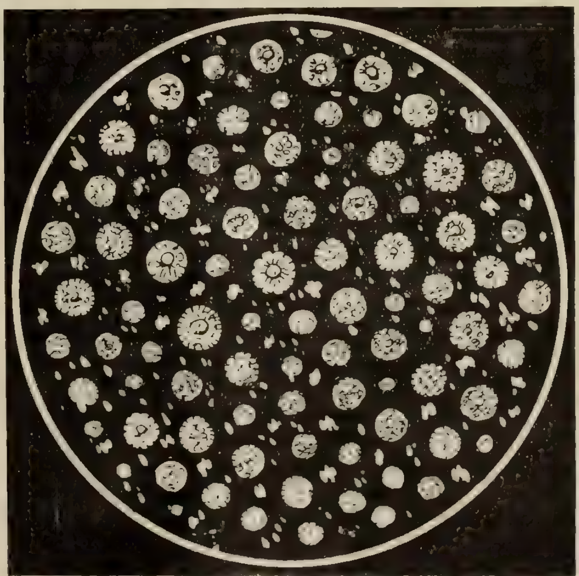
As it is imperative not to use for industrial pro-



No. 2.—One twenty-fourth inch portion of a layer of fluxing oleic acid after it has completely cooled from the melted state (magnified).

cesses any fats which are capable of being converted into food, the truly edible varieties have to be separated from the remainder, and the latter worked up into suitable grades available for the use of the engineer.

Even tallow, the membraneless fat boiled out from beef and mutton suet, which has found so much favour on behalf of lead soldering, has been kept



No. 3.—One twenty-fourth inch portion of a layer of fluxing oleic acid melted and cooled between two pieces of glass (magnified).

back from the workshop on account of food shortage.

In examining the fluxing oleic acid in question, it is seen to be a thick, yellowish, oily fat, of about the consistence of honey. When it is melted it of course passes into the condition of a transparent oil

which, when allowed to cool, becomes again an opaque fat. Now, these contrasts are due to very specific causes, and depend on a kind of minute crystallisation. If we magnify the oleic acid fat while it is melting, numbers of minute flakes, globules, and so on, can be detected separating from each other, dwindling in individual dimensions, and finally vanishing, like ice becoming water, as it were.

The reverse progress of events occurs as the oleic acid oil reverts to oleic acid fat, as we see a host of tiny particles spring up suddenly in it, enlarge, and join together, while similar wafers appear within the interstices between them, the result being that fluid turns to solid.

We can tell, to a certain extent, by the shapes of these rough crystals, how much of the higher fatty acids stearic and palmitic is associated with the oleic. The presence of these higher fatty acids is responsible for the stiffness of the flux to which I am giving attention; otherwise, it would be a mere oil at ordinary temperatures.

By the way, it is quite orthodox to speak of an oleic-acid rich fat succinctly as oleic acid, although it is fully known that it also contains stearic acid and palmitic acid, and probably some combined glycerin. Oil and fat analysts usually estimate these combined acids as oleic acid, unless they are very obviously abundant. There is not such a wonderful difference between the three fatty acids after all. By incorporating additional hydrogen with oily oleic-acid it is converted into stearic acid and palmitic acid, according to treatment. This process is termed hydrogenation.

Still, the three acids are very distinct when isolated from one another, so far as crystalline possibilities are concerned.

In the illustrations are shown the results of my microscopical observations on the fluxing oleic acid. In No. 1 can be seen the forms referred to springing up in the semi-fluid, cooling fat. Within a second or two spaces between them are filled with others, and a compact layer obtained.

In No. 2 can be seen the surface of the wholly-cooled fat, this figuring being due to contraction.

In No. 3 can be seen the result of cooling the melted fat between two strips of glass, thereby preventing obscuring fusion. Other figures could be added, but space forbids.

It is evident that what happens is this: As the melted fat is cooling it produces myriads of freckled globules, which unite together into all manner of wrinkled forms until the whole fat is solid. Finally, cellular spaces appear in it, due to the shrinkage of partly hollow globules, the outer ridges projecting like a network. During the molecular straining necessary to produce these effects, the obnoxious gases, etc., are absorbed sponge-like.

It must be borne in mind that oils—and melted fats are oils—have a tendency to move away from heated environments, as anyone can tell by warming some on glass over a flame, preferably that of a spirit such as alcohol or benzol, as no soot is then formed. This conduct must be of advantage in fluxing, because the oleic acid must be continually turning over laden with its abstracted matter, and trying to pass away and leave the metal clean.

MOTORCYCLE DESIGN.

By D. S. Heather, B.Sc.

(Continued from page 405.)

Transmission.

It is now generally recognised that the belt is not a satisfactory means of transmitting power from the engine to the rear wheel of a motorcycle, and its retention on some models is doubtless due merely to its efficiency as a shock absorber. The old direct form of belt drive is already practically dead, but the chain-cum-belt system is still used on numerous machines. The failure of the direct belt drive was, of course, due to the fact that the conditions under which it had to be installed on a motorcycle were such that it could not operate efficiently. The gear reduction was large, the centre distance between the pulleys was absurdly short, and the arc of contact of the belt on the small pulley was very small. Further troubles were due to the inefficiency of the drive owing to the power absorbed in bending a stiff Vee-belt round a small pulley, and to the fact

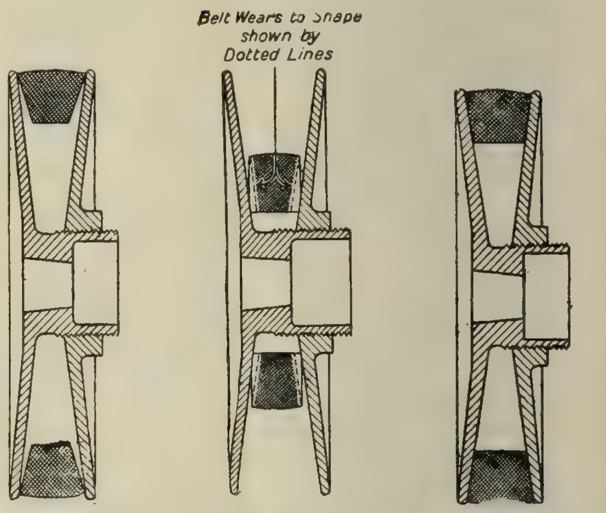


Fig. 1.—New Belt at top of Pulley. Fig. 2.—Showing distorted shape of Belt at bottom of Pulley. Fig. 3.—Worn Belt returned to top of Pulley.

that the belt could not adequately be protected from wet. The adoption of the countershaft drive improved matters by enabling a large pulley to be used, with consequent greater efficiency and longer life of the belt. This, however, made the centre distance still shorter, except in the case of the Zenith, and, in conjunction with the countershaft gearbox, forced the belt to take very heavy loads at low belt speeds, when the indirect gears were in operation. The author's experience has taught him that, when a sidecar is fitted, it is necessary to keep the belt so tight in order to prevent it slipping when the throttle is open on the bottom gear, that the belt invariably breaks on bad hills. Incidentally, this necessity for keeping the belt so tight largely removes its shock absorbing qualities, and the drive is then not so sweet as that provided by a positive transmission in conjunction with an efficient mechanical shock absorber. Taken altogether, the belt is not a satisfactory means of power transmission for motorcycles, and its retention cannot be justified.

It has been much praised because of the possibility

of using it, in conjunction with a sliding flange pulley, as an infinitely variable gear, but examination shows that such a form of change speed gearing cannot be altogether desirable. In Fig. 1 is shown a correct section of a Vee-belt fitting accurately into the pulley flanges. Unfortunately, however, such a state of affairs is never obtained, because, when a Vee- belt is bent round a pulley, its section is distorted, so that the top of the belt becomes narrower, and the bottom wider, the section approaching more nearly to the rectangular. The change of section is of course greater as the diameter of the pulley becomes smaller, so that although it would not be serious on a twelve inch pulley, it would be very serious on a four inch pulley. Suppose, therefore, that Fig. 1 represents the state of affairs when an infinitely variable gear of the type under consideration is in top gear position. The pulley flanges are then opened out, and the belt drops down, until it is bent round a smaller radius so that its section is distorted. The state of affairs then existing is shown in Fig. 2, the belt riding on the pulley on its two inner edges only. The small contact between the belt and the pulley causes slipping to take place until the belt is worn into the shape indicated by the dotted lines. If the belt is now run up to the top of the pulley again, it will ride as shown in Fig. 3, on its outer edges, and these edges will wear away until the belt again beds in. Thus each time a change of gear is called for, wear takes place, so that the life obtained from the belt is short. Moreover, all this slipping, and wearing away of the belt spells inefficiency, for work is done in removing rubber from the belt sides which should be expended in propelling the machine.

(To be continued.)

ENGINEERING LAY-OUT ARRANGEMENTS AND TENDER DRAWINGS.

By Douglas Wilson, A.M.I.Mech.E.

(Continued from page 286.)

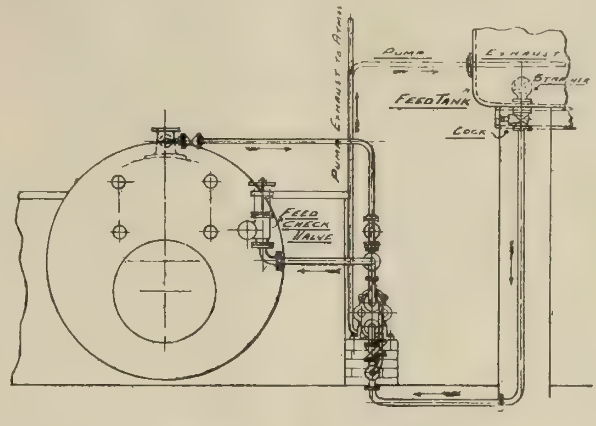
Feed-Water Heating.

Heating the feed water before it enters the boiler is well known to be a money saver, as for every 10 deg. rise in the temperature of the feed water it has been found that a saving of one per cent in fuel is effected, also the evaporative efficiency of the boiler is greatly increased, the life of the same also being lengthened.

The economiser is perhaps the most economical method of raising the temperature of the boiler feed water, provided of course that the plant lends itself to the installing of one. Most steam installations now-a-days find it a necessity to put down economisers on account of the high pressures now in use and the consequent high temperature of the flue gases. A large reserve of hot water from 200 deg. to 300 deg. F. can always be available with an economiser for any sudden demand. The reader is doubtless familiar with the well-known Green type of economiser, this being the type referred to.

Where economisers are not installed and exhaust steam is available, the exhaust steam heater then takes the place of them very well. Temperatures up to 206 deg. F. have been obtained by this simple apparatus. The exhaust steam from non-condensing engines, steam hammers, pumps, &c., can be led directly into the heater, and the final temperature of the water differs very slightly from the temperature of the steam itself.

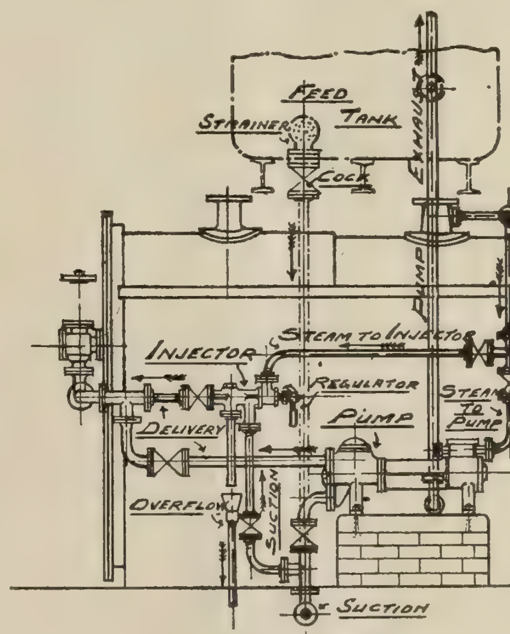
For raising the feed water temperature to within a few degrees of the boiler temperature itself, the live steam heater will do this, and by so doing a resulting economy has been proved to be about 8 per cent. The



Engineering Lay-out.—Fig. 64.

feed water for this type of heater would be taken from the hot well for this efficient result. The reader will thus be able to see under what conditions the above three methods of heating the boiler feed water lend themselves to most suitably.

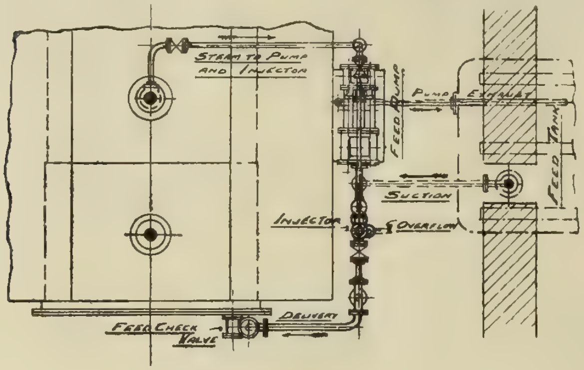
As previously stated, where a boiler is fed by an injector, a feed pump should always be installed as a stand-by. The method of arranging the pipes, &c., for this is shown at Figs. 64, 65, and 66. As will be



Engineering Lay out.—Fig. 65.

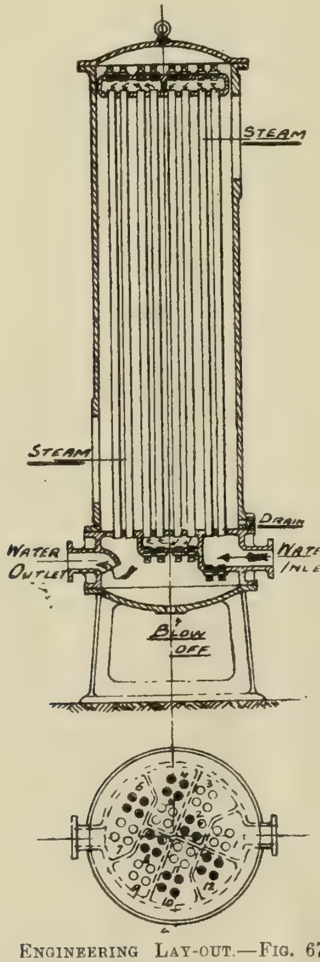
seen, the pump, which is of the Worthington Horizontal Duplex type, is close to the injector, both being as near to the boiler as possible. The feed tank is placed at a convenient height, and the exhaust steam from the pump passes through it, thereby slightly taising the temperature of the water—the amount, of course, depending on the size of the tank. Where the tank is of a large

capacity, and no hot water is available for filling same, a steam jet can be used to advantage, of the Meldrum or Korting type. This jet may be fixed in the side of the tank close to the bottom, and discharge the steam



Engineering Lay-out.—Fig. 66.

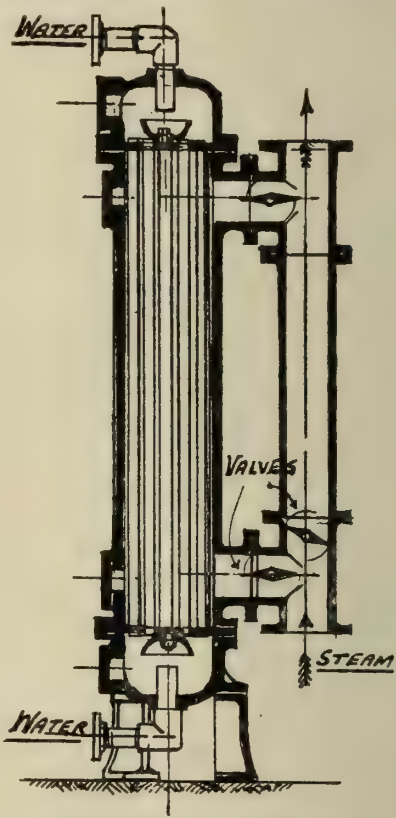
directly into the water. The temperature of the water will, of course, be governed by the size of the jet used; only a small steam supply is required to heat the water—say 200 gallons per hour—to boiling point. This would mean a 1-in. live steam supply at 50 lbs. pressure. Referring to the arrangement again, it will be seen that



Engineering Lay-out.—Fig. 67.

valves in the piping are so arranged that the injector can be at once cut out and the pump set to work in its place. When hot water is used for the pump it is imperative to have a head on the suction, as illustrated, the head being increased as the temperature of the water increases. In most important installations feed pumps in duplicate are recommended, and are most generally adopted, in lieu of the injector, as stand-by. When selecting the size of the pump for any particular capacity it is always advisable to allow an ample margin, say, 30 per cent to 50 per cent, For example, take a boiler having a normal evaporation of 3,000 lbs. per hour, the size of pump suitable should be capable of delivering at least 400 gallons per hour against the maximum working boiler pressure. Boiler feed pumps are generally now of the duplex piston or single direct acting types, the latter pattern being vertical, and many of these pumps, particularly of the "Weir" and "Woodeson" types, are largely used in high-class steam plants.

The capacity of the feed tank is a matter of choice to a certain extent, certainly the larger the better. For



Engineering Lay-out.—Fig. 68.

small plants, say one boiler, the tank capacity could be almost equivalent to one hour's evaporation, provided the pump or injector has another source, a river or canal, to draw its suction from. The capacity of tank should be equal to the water capacity of the boiler if the former has to rely for its filling on, say, a small pump driven by power supplied from the boiler.

The feed tank should be as near the boiler house as possible, and should be closed in.

Exhaust steam heaters are largely used on small steam plants, destructor installations, &c., and take up very little floor space. They are a simple piece of apparatus, and there is not much to choose between the several types on the market.

Figs. 67 and 68 show two patterns, the former made by Messrs. Holden and Brooke, and the latter by Messrs. Babcock and Wilcox. As will be seen, the first heater

consists of a cast iron casing or body, in which are assembled a number of vertical brass tubes, the bottom ends of which are expanded into a plate, which forms the top of the water inlet and outlet box, and the top ends being expanded into a floating head. There are twelve groups of four tubes each, the dotted lines in the plan indicating the compartments in the lower chamber to which the tubes have access, the top head also being suitably chambered.

The water enters by the right-hand branch up the set of tubes marked 1, down those marked 2, up those marked 3, and so continuing this up and down flow until it finally passes down the set 12, thence out at left-hand water branch. The tubes in which the water flows upwards are shown blacked in, and those in which the water descends open circles. By this arrangement it will be seen that the maximum amount of heat is extracted from the incoming steam, and a high final temperature obtained in the water. The water is compelled to pass through a great length of tubing, but also does so at a high velocity, this being a distinct advantage, as any stagnant film of non-conducting water often present in slow circulation heaters is quickly destroyed.

(To be continued.)

ECONOMIES IN THE GENERATION AND USE OF STEAM.

By Sidney F. Walker, R.N., M.I.E.E., M.I.M.E.

(Continued from page 373.)

The Question of the Boiler.

As indicated above, the boiler that is to use gas as a fuel must be specially constructed. It must have its own special furnace in which the gas will be burnt in accordance with the heat required and in proportion to the calorific value, and the hot gases formed by combustion must be led from the furnace over a succession of metal surfaces, on the other side of which the water and the steam impinge.

If we look at the present form of boiler, from a scientific point of view, it must appear to us very crude, and in the mater of crudity there is really not much to choose between the Lancashire and the water-tube boiler. Both have done very good service, and it sounds like the height of ingratitude to speak of them in these terms, but if a little consideration is given to the matter, the writer believes the truth of the above will be seen. In both cases we have a large volume of hot gas with an initial temperature of from 2,000 deg. to 3,000 deg. Fah. flowing, in the one case, through large tubes and large side flues; and in the other case through large spaces directed by baffles over the surfaces of the tubes in which the water is flowing. It is well known that both gas and water, as well as steam, are very poor conductors of heat, and it is only the skin of gas flowing against the metal heating surfaces, the surfaces of the flue tubes, the surfaces of the boiler in the side and bottom flues, and over the water tubes in the water-tube boiler that perform any useful work, in delivering heat to the water, or to the steam on the other side of the metal heating surfaces. The great mass of the gas flows by without doing any useful heating. In both forms of boiler the original designers were handicapped by having to provide for the grate and the furnace in which the coal is burnt. It was necessary to carry as large a fire as possible in order to have a large mass of incandescent fuel, constantly furnishing a volume of hot gas to be carried off through the boiler flues and over the boiler tubes. In order that the fires might also burn, it was necessary that the flues should be large, or difficulties would arise in the matter of draught, and in providing the necessary quantity of air for the combustion of the fuel. With the advent of the mechanical stoker and mechanical draught, that difficulty has partly disappeared. So far, no advantage has been taken of the fact, beyond carrying thicker fires and a higher initial temperature leading to a higher efficiency. The crude arrangement of the large volume of hot gases flowing through large tubes and over large surfaces remains. There is, of course, one exception to this; the arrangement of the marine boiler, and what is known as "the dryback boiler," in which the hot gases are made to flow through a large number of tubes. This is a great improvement upon both the Lancashire and water-tube boilers, splitting up the volume of hot gas into a number of small streams, which should increase the efficiency of the boiler by bringing a larger portion of the gas into active service. The Scotch boiler is a quick steamer and very efficient, but it is doubtful whether even in that form of boiler the best results have been obtained; such results as could have been obtained by the aid of gas.

On the other hand, on the waterside, in the case of the Lancashire boiler, the same crudity is shown. The heat delivered by the hot gases has to find its way into the mass of the water by the aid of convection currents, the great mass of the water takes no part in conducting the heat through itself. In the water-tube boiler this has been largely remedied, but the defects of the heating system, of the method of delivery of the heat from the hot gases to the water remains.

In the ideal boiler there would be a large number of metal diaphragms, preferably of copper. The hot gases provided by the combustion of the gas, would flow on the underside of these diaphragms, and the water to be converted into steam, and the steam already formed from the water would flow on the other side in the opposite direction. The writer is aware that such an arrangement would be very difficult indeed, almost impossible to carry out. Probably the nearest approach would be a nest of tubes through which the hot gases would flow, the water filling the spaces all round the tubes. The smaller the tubes the more efficient should the arrangement be, and also the smaller the spaces between the tubes. Again, the writer appreciates that it would be difficult to employ very small tubes and very small spaces between them. He also foresees difficulties in the way of abstracting the whole of the heat delivered to the hot gases, the products of combustion, from the burning of the gas in the furnace. He would like to see, if nests of tubes were employed, the hot gases flowing to and fro through successive banks of tubes in a similar manner to that in which the tubes of the surface condensers are arranged. If the fire tubes, the tubes in which the gases were flowing, could be made very small and divided into several banks, it should be possible to abstract nearly the whole of the heat from the hot

gases, to deliver them to the chimney at a temperature, say, not exceeding 200 deg. Fah. If the temperature in the furnace were 3,000 deg. Fah., and the temperature of the chimney 200 deg. Fah., it can be seen what a very efficient boiler it might be. Compare this with the practice of a large number of boilers still in use. A furnace temperature of 2,000 deg. Fah. to 2,400 deg. Fah., and a chimney temperature of 600 deg. Fah., and sometimes as much as 800 deg. Fah.

The question of draught also should be very much simplified; the provision of air for combustion at the gas burners could be arranged by means of forced draught or induced draught. Probably forced draught would be more convenient, and in the end more efficient, because it would be more easily controlled. It should be remembered again that the conditions for the supply of air for burning gas in such a boiler would be quite different from those ruling in both Lancashire and water-tube boilers, whether they use coal or gas as fuel. Again, when gas is used in one of the boilers at present on the market, the question of draught is rendered difficult by the arrangement of the flues in one case, and the passages over which the hot gases flow in the other case. In both cases large volumes of air have to be set in motion in order to provide that necessary for combustion, because of the large spaces the hot gases have to occupy; while, on the other hand, only comparatively small spaces are really required to accommodate the air necessary for combustion. One of the greatest difficulties in connection with the burning of ordinary town gas, both for heating and for lighting, is the arrangement of the supply of air in accordance with the requirements of the burning gas. Most of us have experienced a good deal of trouble with the gas apparatus in our homes since the calorific value of the gas has been reduced owing to the Gas Companies making by-products for the Government to be converted into explosives. In most cases the supply of air has been too large, and the gas has had a nasty knack of lighting back. It has only been a little matter to put the thing right when you knew how, but it was often very exasperating. In the writer's view, a good deal of the trouble that has arisen in connection with the firing of boilers by gas has been due to the difficulty of regulating the supply of air. When you have air coming in through the ashpit and the grate and filling up the large spaces in the boilers where the hot gases flow, it appears to him that it would be difficult to regulate the supply, particularly where the calorific value of the gas varies. A good deal may be done by closing up the ashpits, but it is rather difficult to close them entirely, and if they are closed there are still the large spaces inside the boiler, that are filled with air when the firing commences, and which have to be filled more or less with hot gases.

(To be continued.)

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FOUNDATIONS.

By W. H. Latham.

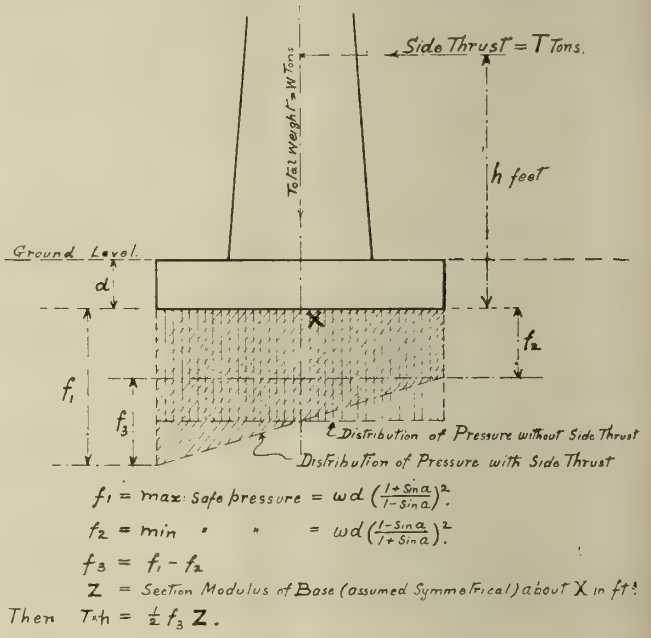
(Continued from page 232.)

Side Thrust.

If the superstructure is exposed to a side thrust T (see Fig. 4) at a height of h feet above the base of the foundation, equilibrium is maintained as follows:—

T has no vertical component, and therefore cannot increase the total pressure on the base. It is opposed by an equal and opposite force, due to the friction between the base and the earth, which forms with T a "couple" having the value $T \times h$.

When there is no side thrust on the superstructure the load W causes a uniform pressure all over the base. The side thrust T causes a change in the pressure distribution; and the load W, and the resultant of the



Foundations.—Fig. 4.

altered pressure under the base form an equal and opposite "couple" Th.

If the pressure under the base varies uniformly from p_2 on the windward to p_1 on the leeward side, it is evidently equal to a uniform pressure $\frac{p_1 + p_2}{2}$ all over the base, and a pressure varying from $+\left(\frac{p_1 - p_2}{2}\right)$ on the leeward to $-\left(\frac{p_1 - p_2}{2}\right)$ on the windward side. This is a case of combined direct and bending stresses, and if the base plan has a section modulus = Z, the bending moment will be $Z\left(\frac{p_1 - p_2}{2}\right)$, which must equal Th. (The value of Z must, of course, be calculated with the foot as unit.)

The values of p_1 and p_2 should not exceed or fall short of the maximum and minimum values of pressure respectively, as given by the Bell or Rankine formula in Table II.

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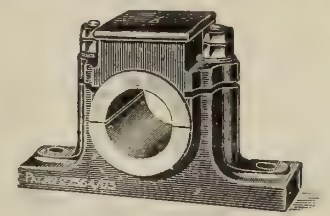

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Beam 8 in. × 5 in. × 29 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 2 10	5 0 20	7 3 2	10 1 12	12 3 22	15 2 4	0 18 0 14	1 0 2 24	1 3 1 6	0
1	0 1 1	2 3 11	5 1 21	8 0 3	10 2 13	13 0 23	15 3 5	0 18 1 15	1 0 3 25	1 3 2 7	1
2	0 2 2	3 0 12	5 2 22	8 1 4	10 3 14	13 1 24	16 0 6	0 18 2 16	1 1 0 26	1 3 3 8	2
3	0 3 3	3 1 13	5 3 23	8 2 5	11 0 15	13 2 25	16 1 7	0 18 3 17	1 1 1 27	1 4 0 9	3
4	1 0 4	3 2 14	6 0 24	8 3 6	11 1 16	13 3 26	16 2 8	0 19 0 18	1 1 3 0	1 4 1 10	4
5	1 1 5	3 3 15	6 1 25	9 0 7	11 2 17	14 0 27	16 3 9	0 19 1 19	1 2 0 1	1 4 2 11	5
6	1 2 6	4 0 16	6 2 26	9 1 8	11 3 18	14 2 0	17 0 10	0 19 2 20	1 2 1 2	1 4 3 12	6
7	1 3 7	4 1 17	6 3 27	9 2 9	12 0 19	14 3 1	17 1 11	0 19 3 21	1 2 2 3	1 5 0 13	7
8	2 0 8	4 2 18	7 1 0	9 3 10	12 1 20	15 0 2	17 2 12	1 0 0 22	1 2 3 4	1 5 1 14	8
9	2 1 9	4 3 19	7 2 1	10 0 11	12 2 21	15 1 3	17 3 13	1 0 1 23	1 3 0 5	1 5 2 15	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	0 2·41	0 4·83	0 7·25	0 9·66	0 12·08	0 14·50	0 16·91	0 19·33	0 21·75	0 24·17	0 26·58	0 29	

Weights of Lengths of Rolled Steel Sections.

Beam 8 in. × 5 in. × 29 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	1 5 3 16	2 11 3 4	3 17 2 20	5 3 2 8	6 9 1 24	7 15 1 12	9 1 1 0	10 7 0 16	11 13 0 4	0
10	0 2 1 10	1 8 1 26	2 14 1 14	4 0 1 2	5 6 0 18	6 12 0 6	7 17 3 22	9 3 3 10	10 9 2 26	11 15 2 14	10
20	0 5 0 20	1 11 0 8	2 16 3 24	4 2 3 12	5 8 3 0	6 14 2 16	8 0 2 4	9 6 1 20	10 12 1 8	11 18 0 24	20
30	0 7 3 2	1 13 2 18	2 19 2 6	4 5 1 22	5 11 1 10	6 17 0 26	8 3 0 14	9 9 0 2	10 14 3 8	12 0 3 6	30
40	0 10 1 12	1 16 1 0	3 2 0 16	4 8 0 4	5 13 3 20	6 19 3 8	8 5 2 24	9 11 2 12	10 17 2 0	12 3 1 16	40
50	0 12 3 22	1 18 3 10	3 4 2 26	4 10 2 14	5 16 2 2	7 2 1 18	8 8 1 6	9 14 0 22	11 0 0 10	12 5 3 26	50
60	0 15 2 4	2 1 1 20	3 7 1 8	4 13 0 24	5 19 0 12	7 5 0 0	8 10 3 16	9 16 3 4	11 2 2 20	12 8 2 8	60
70	0 18 0 14	2 4 0 2	3 9 3 18	4 15 3 16	6 1 2 22	7 7 2 10	8 13 1 26	9 19 1 14	11 5 1 2	12 11 0 18	70
80	1 0 2 24	2 6 2 12	3 12 2 0	4 18 1 16	6 4 1 4	7 10 0 20	8 16 0 8	10 1 3 24	11 7 3 12	12 13 3 0	80
90	1 3 1 6	2 9 0 22	3 15 0 10	5 0 3 26	6 6 3 14	7 12 3 2	8 18 2 18	10 4 2 6	11 10 1 22	12 16 1 10	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	12 18 3 20	25 17 3 12	38 16 3 4	51 15 2 24	64 14 2 16	77 13 2 8	90 12 2 0	103 11 1 20	116 10 1 12	129 9 1 4	

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Weights of Lengths of Rolled Steel Sections.

Beam 10in. × 5 in. × 28·5 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 2 5·0	5 0 10·0	7 2 15·0	10 0 20·0	12 2 25·0	15 1 2·0	0 17 3 7·0	1 0 1 12·0	1 2 3 17·0	0
1	0 1 0·5	2 3 5·5	5 1 10·5	7 3 15·5	10 1 20·5	12 3 25·5	15 2 2·5	0 18 0 7·5	1 0 2 12·5	1 3 0 17·5	1
2	0 2 1·0	3 0 6·0	5 2 11·0	8 0 16·0	10 2 21·0	13 0 26·0	15 3 3·0	0 18 1 8·0	1 0 3 13·0	1 3 1 18·0	2
3	0 3 1·5	3 1 6·5	5 3 11·5	8 1 16·5	10 3 21·5	13 1 26·5	16 0 3·5	0 18 2 8·5	1 1 0 13·5	1 3 2 18·5	3
4	1 0 2·0	3 2 7·0	6 0 12·0	8 2 17·0	11 0 22·0	13 2 27·0	16 1 4·0	0 18 3 9·0	1 1 1 14·0	1 3 3 19·0	4
5	1 1 2·5	3 3 7·5	6 1 12·5	8 3 17·5	11 1 22·5	13 3 27·5	16 2 4·5	0 19 0 9·5	1 1 2 14·5	1 4 0 19·5	5
6	1 2 3·0	4 0 8·0	6 2 13·0	9 0 18·0	11 2 23·0	14 1 0·0	16 3 5·0	0 19 1 10·0	1 1 3 15·0	1 4 1 20·0	6
7	1 3 3·5	4 1 8·5	6 3 13·5	9 1 18·5	11 3 23·5	14 2 0·5	17 0 5·5	0 19 2 10·5	1 2 0 15·5	1 4 2 20·5	7
8	2 0 4·0	4 2 9·0	7 0 14·0	9 2 19·0	12 0 24·0	14 3 1·0	17 1 6·0	0 19 3 11·0	1 2 1 16·0	1 4 3 21·0	8
9	2 1 4·5	4 3 9·5	7 1 14·5	9 3 19·5	12 1 24·5	15 0 1·5	17 2 6·5	1 0 0 11·5	1 2 2 16·5	1 5 0 21·5	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs. 2·375	lbs. 4·75	lbs. 7·125	lbs. 9·5	lbs. 11·875	lbs. 14·25	lbs. 16·625	lbs. 19·0	lbs. 21·375	lbs. 23·75	lbs. 26·125	lbs. 28·5	Weight.

Weights of Lengths of Rolled Steel Sections.

Beam 10 in. × 5 in. × 28·5 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	1 5 1 22	2 10 3 16	3 16 1 10	5 1 3 4	6 7 0 26	7 12 2 20	8 18 0 14	10 3 2 8	11 9 0 2	0
10	0 2 2 5	1 7 3 27	2 13 1 21	3 18 3 15	5 4 1 9	6 9 3 3	7 15 0 25	9 0 2 19	10 6 0 13	11 11 2 7	10
20	0 5 0 10	1 10 2 4	2 15 3 26	4 1 1 20	5 6 3 14	6 12 1 8	7 17 3 2	9 3 0 24	10 8 2 18	11 14 0 12	20
30	0 7 2 15	1 13 0 9	2 18 2 3	4 3 3 25	5 9 1 19	6 14 3 13	8 0 1 7	9 5 3 1	10 11 0 23	11 16 2 17	30
40	0 10 0 20	1 15 2 14	3 1 0 8	4 6 2 2	5 11 3 24	6 17 1 18	8 2 3 12	9 8 1 6	10 13 3 0	11 19 0 22	40
50	0 12 2 25	1 18 0 19	3 3 2 13	4 9 0 7	5 14 2 1	6 19 3 23	8 5 1 17	9 10 3 11	10 16 1 5	12 1 2 27	50
60	0 15 1 2	2 0 2 24	3 6 0 18	4 11 2 12	5 17 0 6	7 2 2 0	8 7 3 22	9 13 1 16	10 18 3 10	12 4 1 4	60
70	0 17 3 7	2 3 1 1	3 8 2 23	4 14 0 17	5 19 2 11	7 5 0 5	8 10 1 27	9 15 3 21	11 1 1 15	12 6 3 9	70
80	1 0 1 12	2 5 3 6	3 11 1 0	4 16 2 22	6 2 0 16	7 7 2 10	8 13 0 4	9 18 1 26	11 3 3 20	12 9 1 14	80
90	1 2 3 17	2 8 1 11	3 13 3 5	4 19 0 27	6 4 2 21	7 10 0 15	8 15 2 9	10 1 0 3	11 6 1 25	12 11 3 19	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs. 12 14 1 24	t. c. q. lbs. 25 8 3 20	t. c. q. lbs. 38 3 1 16	t. c. q. lbs. 50 17 3 12	t. c. q. lbs. 63 12 1 8	t. c. q. lbs. 76 6 3 4	t. c. q. lbs. 89 1 1 0	t. c. q. lbs. 101 15 2 4	t. c. q. lbs. 114 10 0 20	t. c. q. lbs. 127 4 2 16	Weight.

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Condition of Ground.

Where strong natural rock outcrops at the surface it may only need dressing and drilling for bolts. Exposed rock faces are, however, usually damaged by weathering, and the damaged material must be removed till a good surface is reached.

The best conditions are where a few feet of earth overlies a rock surface protecting it from weathering. The rock surface may be levelled by dressing away or cleaning off and filling up with concrete, which is usually cheaper, though in such cases, the safe load will be limited to that of the concrete.

For foundations on the secondary strata, clays, shales and gravels, the necessary depth can be determined by the Rankine or Bell formula. The values of w, k and the angle A are constants for any given material, and the value of P may be calculated for any depth. It will be noticed, according to the formula, P should increase in value with the depth which is found to be the case in practice. The values given in Table III. are averages determined by experience, and Table IV. gives instances of actual practice. For light loads and strong materials the least depth is generally made sufficient to prevent rainwater percolating under it and to get below the penetration level of frost. Professor H. Adams gives the least depth as 2 ft. 6 in. on gravels and 5 ft. on clays.

Testing of Ground.

The carrying capacity of ground may be determined by direct loading. A pit is sunk or a borehole made to the desired depth. A base-plate of convenient size is fixed on the end of a steel joist C.I. pipe or timber balk and lowered into the pit to rest on the bottom, being guided above ground by cross timbers. The plate should almost cover the bottom of the hole or the earth should be filled in again. The stanchion is then marked at a definite height above the cross timbers and loads are applied until settlement begins. The stanchion is left with this load for 24 hours and the settlement observed; no further addition being made to the load till the stanchion remains 24 hours without settlement. There are two extreme cases in this test, firstly, the settlement may go on continuously even under a light load, and the foundation would have to be taken further down to find a firm bed; secondly, there may be no movement after the first load is applied in spite of increased loading.

Generally, on secondary strata, settlement occurs at each fresh loading, but does not go on indefinitely. If the depth of the test-plate is d feet, and the proposed loading is W tons per square foot, the total settlement under this loading should not exceed $\left(\frac{d}{12} + \frac{1}{2}\right)$ inches after seven days.

For a nine-storey building at New York a 16 in. pipe was driven to 36 ft. deep; cleaned out inside and a 10 in. pipe with a 14 in. diameter cast-iron disc on the end lowered into it and loaded with 13 tons weight. The total settlement, after 23 days, was $3\frac{15}{32}$ in., and the New York Building Department accepted the result as showing a capacity of 12 tons per square foot.

The cylinders for the Walney Bridge at Barrow-in-

Table No. 4.

Actual Loads on Foundations.

Proceeding No.	Page.	Description.	Load.		Notes.
CXCVIII.		Montreal Grain Handling Plant	7000 per sq. in.		Made ground with piles.
Do.		Des Moines River Viaduct	3 tons	do.	Soft yellow clay 10 ft. below surface, 7 ft. 6 in. diameter, C.I. cylinders 14 ft. 6 in. into sea bed, filled with 1-3-8 concrete 200 tons test load, 6 ft. deep into white clay, 16-12 ft. piles under each foot, 144 altogether.
CXCVII.		Gibraltar Viaduct	..		
CXCII.		Water Tower at Kuching	1·09 tons	do.	
CXCI.		Crewe Coal Bunker	5 tons	do.	Steel column base on concrete.
CXCI.		Dantzig reinforced concrete chimney	·9 tons	do.	
CXC.		Caban Cock Dam — Empty	$9\frac{1}{2}$	do.	
		Caban Cock Dam — Full	6	do.	Conglomerate rock 20 ft. below river bed.
CXC.		Blackfriars Bridge, London	5	do.	Thames ballast 19 ft. below O.D.
CLXXXIII.		Wellington Street Viaduct, London	1·5	do.	Thames mud 6 ft. deep.
Do.		Holborn Subway	·4	do.	Thames mud.
Do.	344	Quebec Bridge, North Caisson	3·4	do.	On rock.
Do.	373	N.Y. nine-storey Warehouse	12	do.	On soil 36 ft. below surface. See notes.
CLXXXII.	11	New Clyde Bridge, Glasgow. Bed of river is about 16 ft. below L.W.O.S.T. and about 25 ft. below H.W.O.S.T.	4·12	do.	50 ft. deep from ground surface, sand and gravel.
			4·73	do.	61 ft. deep from ground surface, sand and gravel.
			4·75	do.	57 ft. deep from ground surface, sand and gravel.
			5·66	do.	43 ft. below river bed, sand.
			5·96	do.	43 ft. below river bed, sand and gravel.
			6·04	do.	48 ft. below river bed, sand and gravel.
			6·12	do.	43 ft. 6 in. below river bed, sand and gravel.
Do.	68	Queen Alexandra Bridge, Newcastle	4·43	do.	78 ft. 6 in. below H.W.O.S.T., on red sandstone.
Do.	268	Walney Bridge, Barrow-in-Furness	5·25	do.	30 ft. below bed, 62 ft. below H.W.O.S.T., stiff clay.
Do.	356	Bremen Grain Silo	2·2	do.	Made ground, sand tipped eight years before.
CLXXXVII.		Loch Leven Waterworks. Blackwater	over 2·7	do.	On granite and mica schist 10 ft. below ground level.
		Dam	max. at toe 5·0 sq. in.		
		Toe	8·6 tons sq. in.		When empty.
		Marlkanve Dam. Average	5·6	do.	Hæmatite quartzite and chlorite schist.
CLXXXIV.		Washington Channel Bridge	4·0	do.	On sand 80 ft. below surface.

Furness were tested by loading with rails to a weight of 6½ tons per square foot, 25 per cent in excess of the working load. The maximum settlement after seven days under this load was ½ in.

In experiments at the Champs-de-Mars, Paris, cast-iron plates loaded to 5½ tons per square foot rested safely upon the ground. At 7¼ tons settlement took place, and with 8½ tons the plates sank out of sight.

(To be continued.)

GOVERNORS AND GOVERNING MECHANISM.

By A. Houlson.

(Continued from page 284.)

Rider Gear.

Fig 55 shows the Rider expansion gear, and Fig. 56 is a perspective view of the same.

In designing a valve gear of this type we may consider the simplest form, viz., a single-slotted valve.

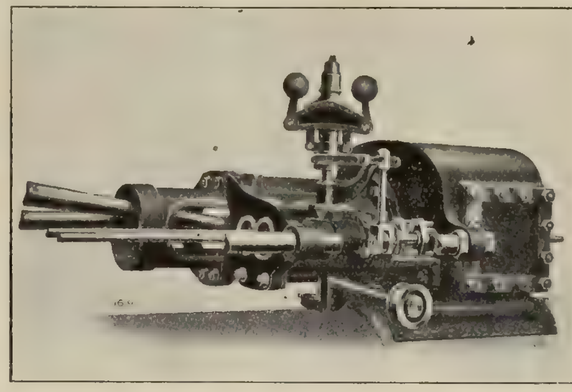
The main valve is shown in Fig. 57, and the expansion valve in Fig. 58.

A development of the inner face of the expansion valve is shown in Figs. 59, 60, and 61.

In Fig. 59 the valve is in the position corresponding to the lowest position of the governor. In Fig. 60 the valve is in its "mid" position, and in Fig. 61 it is in the position corresponding to the highest position of the governor.

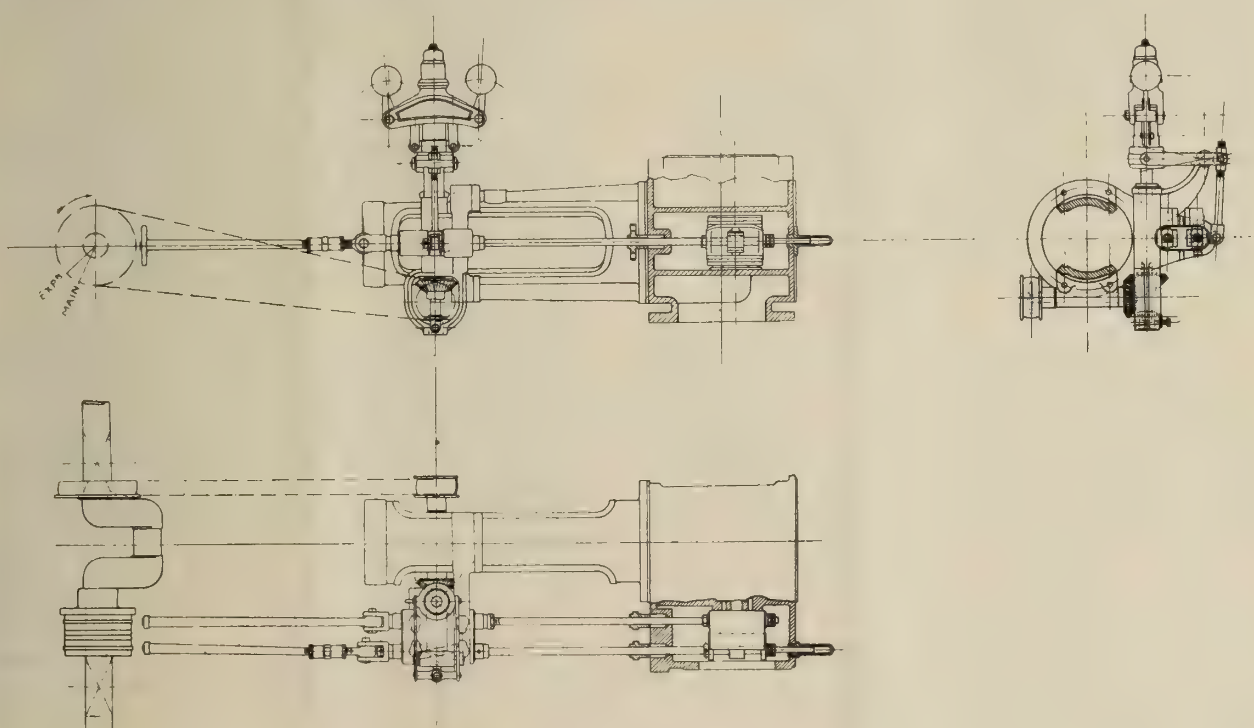
The Zeuner diagram is shown in Fig. 62. Here O M is the main eccentric, O E the expansion eccentric. O Y. in Fig. 62 = L; in Fig. 57 (the steam lap) l = exhaust lap.

The maximum port opening M K is a quantity that varies with the judgment of the designer, and may give velocities from 85 to 100 ft. per second. The lead also is left to the designer's discretion, but is seldom less than $^1/_{16}$ in.



Governors.—Fig. 56.

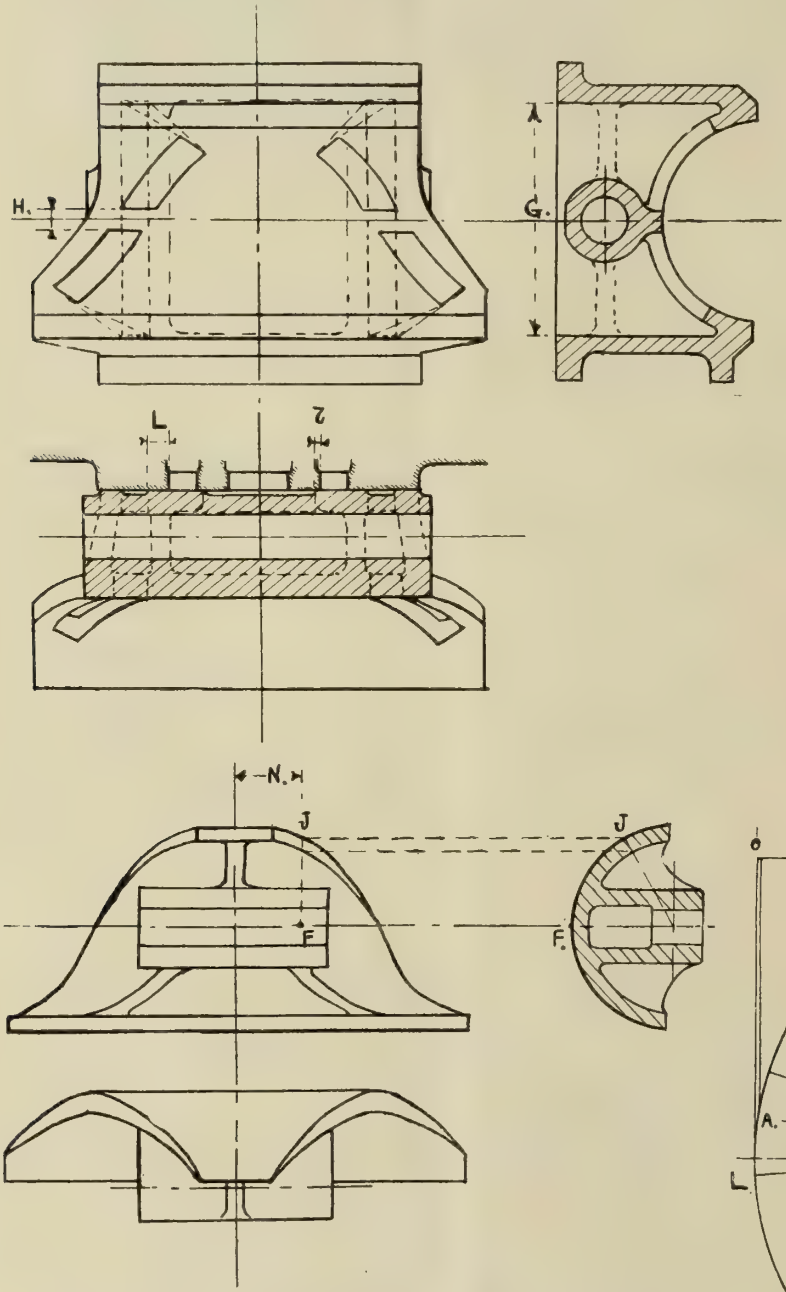
O Q and O R each parallel, and equal to M E, are diameters of the relative travel circles. O P is the maximum positive lap of the expansion valve (represented by c in Fig. 61), and corresponds to the highest speed of the governor. O S is the negative lap at "mid" position (b in Fig. 60), and corresponds to the normal speed of the governor. Therefore, assuming the expansion valve to have equal movments d and e (Figs. 61 and 59) each side of the "mid" position, the maximum negative lap is a in Fig. 59 and O W in Fig. 62. Hence the governor does not control at this late cut-off position. This is immaterial, as it is only a starting position. On the other hand, this arrangement gives a good distribution of loads for a given range of speed. The steamway through the slot in the expansion valve and the port



Governors.—Fig. 55.

in the cylinder are shown for the "mid" position of the expansion valve in Fig. 62. A few temporary radii 02, 03, are drawn between the admission line O L and the cut-off line O B. Taking the radius 03 for example, the distance S O C_1 from the circumference of the circle radius O S to the intersection C_1 of the radius 03 with the relative travel circle O R is the horizontal amount of the slot opening.

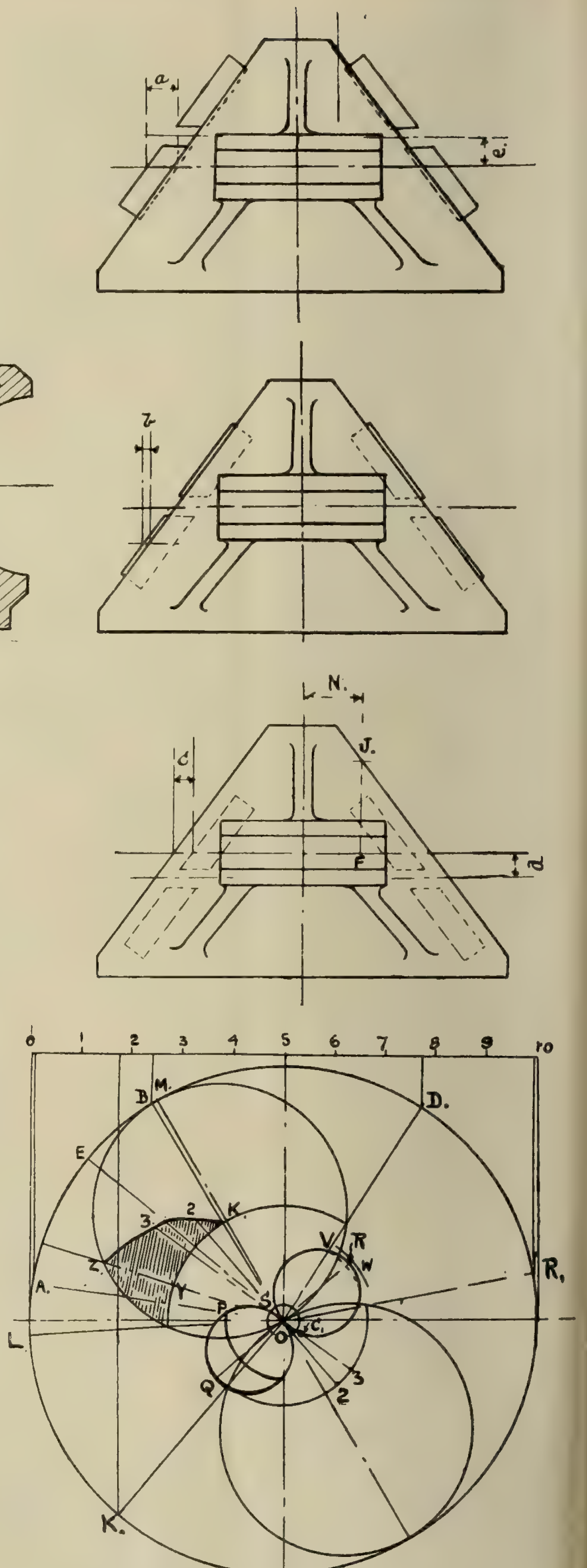
On the radius 02 (at right-angles to Q R) the opening = O S (the negative lap). The results for each position are measured and tabulated. The



Figs. 57, 58.

effective slot opening = .707 × horizontal slot opening (the slots being set at 45 deg.).

The effective slot area is the effective slot opening × length slot. If more than one slot is used take the aggregate length. Allow for obstructions due to spindle boss, etc., *e.g.*, H, Fig. 57.



Governors.—Figs. 59, 60, 61, 62.

The effective port opening = effective slot area ÷ depth of port G (Fig. 57). This latter quantity is set off (for each position) exterior to the main lap circle as shown by the etched portion, Fig. 62, and shows the steamway from admission to cut off.

Referring to Figs. 58 and 61, the projection of the bounding curves of the expansion valve are shown.

The distance F J is measured circumferentially and is set off in the development, Fig. 61.

(To be continued.)

INDUSTRIAL STONEWARE.

The average engineer, aside from those concerned in particular industries, has little or no conception of the vast quantity and variety of fired clay products which fill mechanical and industrial needs. Vessels bearing a close resemblance to usual cast-iron shapes

Industrial Stoneware.

and dimensions, including some impossible in the metal foundry, are made by the oldest mechanical device extant—the potter's wheel.

Centrifugal exhaust fans for acid fumes are made in vitreous stoneware, while possibly the most difficult of all are pipe coils for condensation, similar to that illustrated herewith. These are a veritable work of art, which cannot fail to elicit interest and admiration from any mechanic who works in metal. The duplication in stoneware of shapes of distinctly engineering character is very usual, although not generally realised. Fire-clay products and crucibles, as well as refractory linings, are essential to furnace work, and evoke no surprise but the duplication of shapes normal to cast iron is a business of some size.

Electrical porcelain is also made in huge quantities, but this is, in the main, of simple shape. In pre-war days the collection on view in front of the Doulton establishment, facing the Albert Embankment of the Thames at Lambeth, was always of interest to the writer, while a recent visit he was privileged to make through their stockyards and warehouses gave him real pleasure.

The past few years have been the busiest ever experienced, since industrial stoneware of the character indicated is used very largely in the manufacture of explosives.

Brought into contact with large and complex pieces of industrial stoneware, the engineer finds that his attitude towards exactitude in dimensions, and his metallic view-point, have to be greatly modified. Wasters are not unknown in the foundry, but in the kiln the disappointments are more severe and vastly more numerous.

There is no uniformity in contraction: two pieces air dried of duplicate size will differ materially after firing. Circular shapes are never quite cylindrical, and plasticity warps the straight article by its own weight before vitrification occurs.

The scant sixteenth of former machine shop practice becomes a full half an inch in stoneware. One moulder, known personally to the writer, threw up his job at a local foundry and sought other employment, because no matter what precautions were taken, a finished casting was always more or less problematical. There was no certainty in the trade, and he was a first-rate man at the business; had he been a potter—well, he might have got over the trouble, because the failures are much more numerous.

The disappointments of the business are many; the metal foundry know some of them, but the potter has to exercise more forbearance than the moulder.

Machining is confined to grinding, a slab of carborundum, or a tile with water and sand serve to give a flat surface. Plug cocks are individually ground in by the same means.

Interchangeability will never affect the business of stoneware.

The coil which is illustrated by the courtesy of Messrs. Doulton and Co., is perhaps the best representative article of what can be done by clay in the hands of the potter for industrial ends. It stands as high as the average man, and is a fine example of mechanical stoneware.

Production of Platinum in Columbia.—Now that the Russian market is closed, the production of platinum in Columbia is of paramount importance, as, with the exception of the Russian Ural district, the only place where this metal is found in important quantities is Choco, a river flowing from the Andes range of mountains in Columbia. It is said that the beds of platinum in Russia will be exhausted in 30 or 40 years; in Choco, on the contrary, fresh beds are continually being discovered. According to a Madrid contemporary, the output of the two regions, in troy ounces, is as follows:—

	Russia.	Columbia.
1911	300,000	12.000
1912	185,381	15 000
1913	178,642	16.000
1914	156,775	17,500
1915	107,774	18.000
1916	78,674	25.000
1917	——	50.000

The present price of platinum is 500 dollars per ounce.

GRAPHICAL AIDS IN MANAGEMENT.

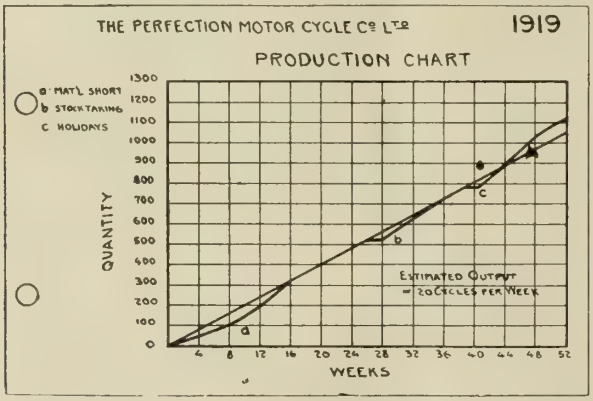
By GEORGE HARRISON.

Foreword.

For many years the designer and draughtsman has used various graphical methods, such as curves, charts and diagrams as aids in his work. They put before him clearly the essentials of his design, and the results of his experience, besides helping to clarify his thoughts to a considerable degree.

It is, however, only within the last few years that the managerial and production side of businesses have come to see the utility and help afforded by graphical aids in organisation and control, due, of course, to the conditions brought about by the mass production of repetition work, and probably to some extent by the infiltration of designers and draughtsmen into works management.

Although the application of graphics in management is still in its infancy, it is growing rapidly, and the writer's aim in this article is to place before the reader a few of the many examples of graphical records applicable to workshop and business management. He is of the opinion that the future general or works manager will refuse to occupy his valuable time in analysing columns of figures,



GRAPHICAL AIDS IN MANAGEMENT.—FIG. 3.

that it is almost impossible for even the mind of a trained accountant to grasp, when by the use of graphical methods the smallest peak or valley in a line will visualise for him the position and progress of various sections of his business or department.

Graphical methods can, like over-elaborated systems, become burdensome, and to make charts because the using of coloured crayons and inks makes pretty pictures is futile, but properly dovetailed into and co-ordinated with the organisation, they are a wonderful help. Even in small general engineering workshops graphical methods of planning will become the rule, and will undoubtedly help in the reduction to a minimum of "idle time," the bugbear of all production managers.

General Management.

It is the function of the management to manage, and it cannot commence to do this until it fixes responsibility for various duties on the respective departments. This is sometimes done by the issue of instructions that a new comer has difficulty in grasping for a long time, but many firms now use responsibility charts, such as the one illustrated in Fig. 1. This shows to which department each sub-department is directly responsible, without elaborate instructions and in the same form, but with the inter-connecting lines varied as required, can also be made to show the various routes which works orders, material requisitions, invoices and other forms should follow. The addition of an appropriate number of crosses on these inter-connecting lines could show the number of forms, duplicate, triplicate or otherwise, passing to each department.

Another form of chart, of which Fig. 2 is a portion, is equally useful, and although more elaborate shows not only the departments but their staffs and duties, and by its means responsibilities are exactly placed. It has the advantage of being flexible, as extra duties can be added and new prints made at little expense.

Other charts useful in this department are the production charts which give the daily, weekly, or monthly output from the works. The charts can be either of the relative or cumulative order and embody both the estimated and actual production.

Fig. 3 shows a chart of the cumulative order giving both estimated and actual weekly production, its construction and use being sufficiently clear without further explanation.

(*To be continued.*)

JIGS, TOOLS, AND SPECIAL MACHINES, WITH THEIR RELATION TO THE PRODUCTION OF STANDARDISED PARTS.*

By HERBERT C. ARMITAGE, of Birmingham, Associate Member.

THE use of jigs and special tools has grown enormously in the last 10 years, and there are very few engineers who have not used jigs, in some degree or form, in the production of their work. Special tools now occupy such a very large place in repetition work that the author makes no apology for presenting a paper on some aspects of them which may be of general interest.

There are many advantages to be derived by the use of jigs and tools, but in this country they have not yet been developed nearly to the extent that is possible. The broad advantages are as follows:—

(1) Interchangeability of the work. This benefit does not necessarily follow from the use of special tools, yet they help very materially towards it, and interchangeable production cannot be obtained without them.

(2) Cheapening of production.

(3) The ability to use a less skilled class of labour on manufacturing and production work.

(4) The elimination of fitting and the introduction of assembling methods.

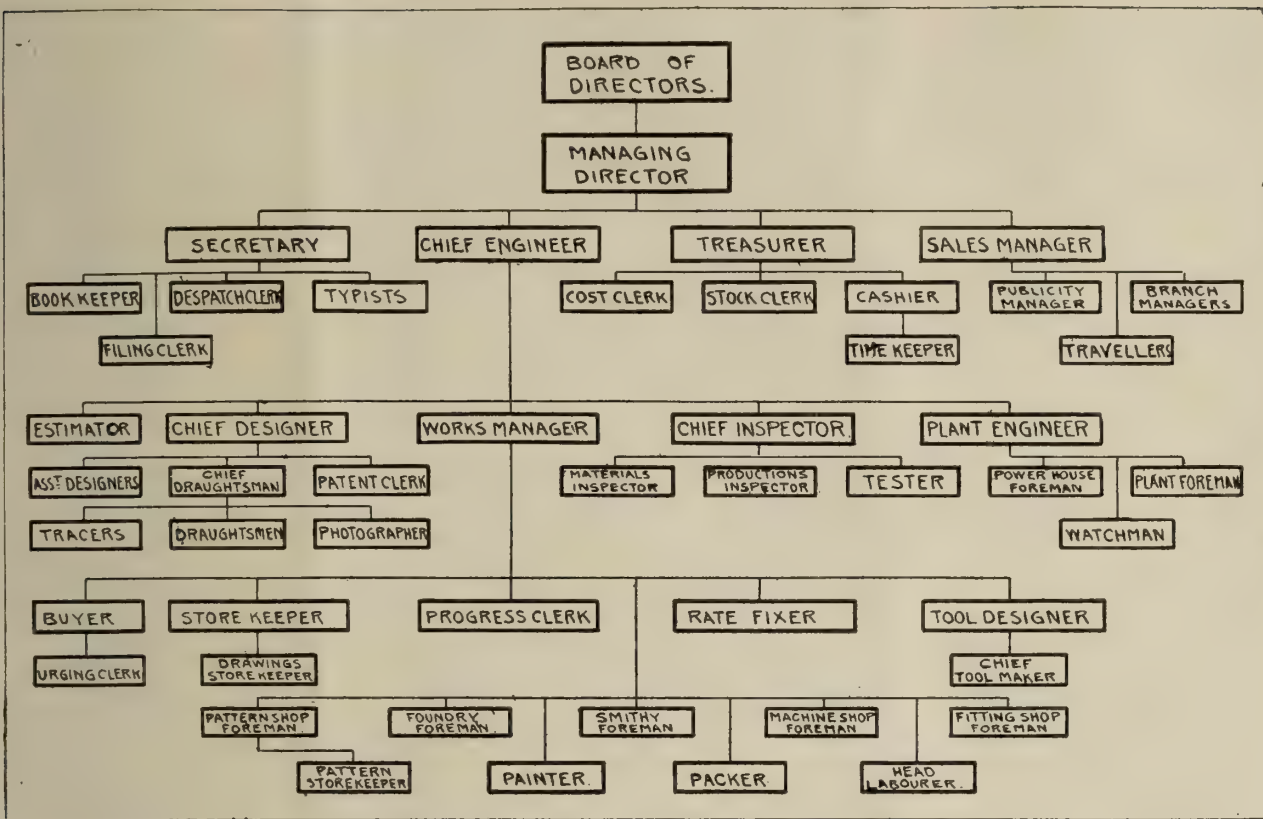
What disadvantages there are can be summed up briefly in the following:—

(1) The use of jigs does not encourage individual ingenuity, skill, or resource, except in a small section of the labour employed.

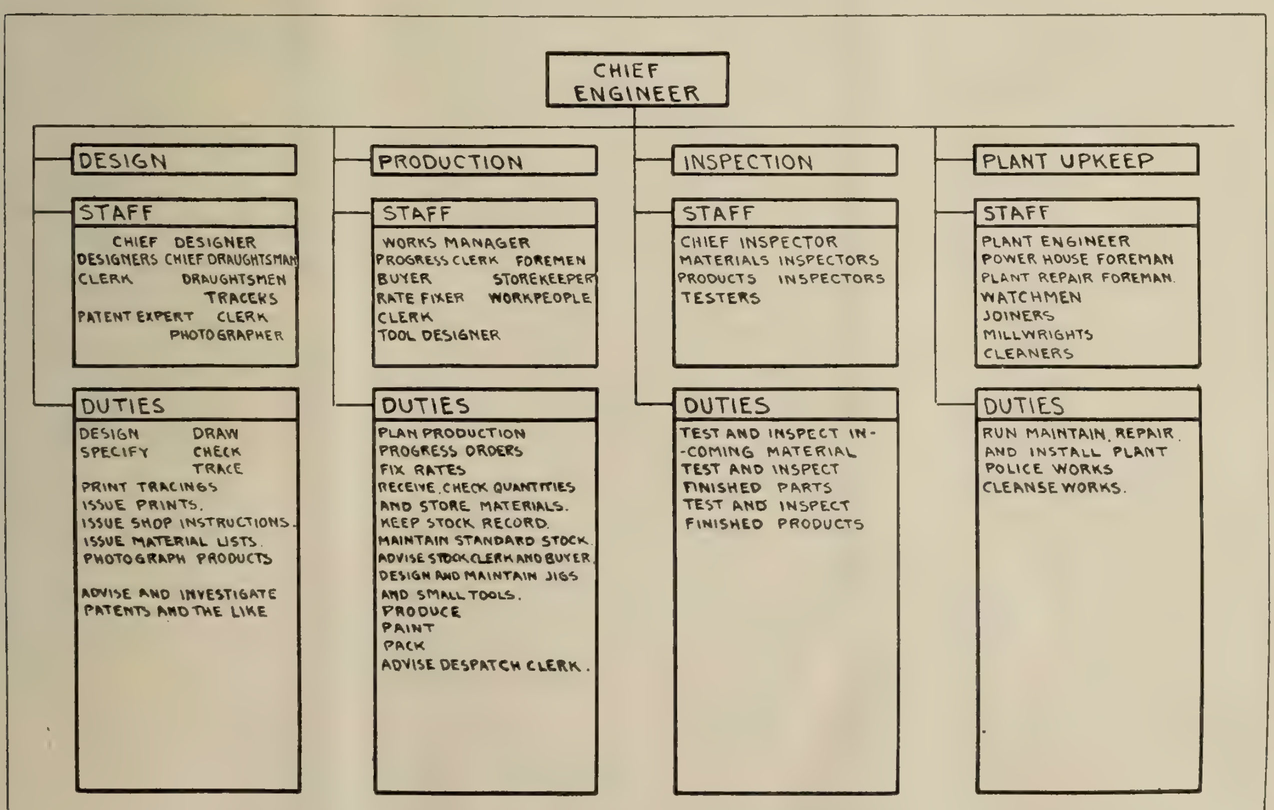
(2) The advantageous use of specialised tool methods requires considerable organisation. This is not liked by the British employee, but he complains very much if there is a lack of system.

(3) Unless the jigs and tools are designed rightly,

* Paper read before the Institution of Mechanical Engineers.



Graphical Aids in Management.—Fig. 1.



Graphical Aids in Management.—Fig. 2.

the results are likely to be as disastrous as if they were not made correctly.

(4) It is usually difficult to synchronise the tool manufacture with the desired production of manufactured parts, due chiefly to the fluctuating requirements of the producing departments.

The ideal system which a firm should cultivate is simply to become staffed and arranged in such a way that full use can be made easily and quickly of a correct relationship between the planning department, the progress department, the tool office, and tool room. If there is a solid foundation upon which to build a good system, the works can expand rapidly with increased business, and in addition there will be little difficulty in changing over from one type of manufacture to another of similar construction.

The effect of the war upon production conditions in workshops has been stupendous. Many firms had laid out their works more or less efficiently for the manufacture of some speciality in comparatively small quantities, and had arrived at accurate manufacture only by "trial and error" methods. In some cases such firms had not altered methods of manufacture for many years, unless forced by competition. In this connection it is interesting to study the types of works organisations in existence in this country at the outbreak of war.

Development of Engineering Manufacturing Methods.

The commencement of the steam-engine era was about a century ago. This, together with the railway boom, developed our oldest engineering concerns. At their commencement there was no mild steel, and the process of cutting metals was second in popularity to the forging, casting, and rolling processes, owing to the latter being much cheaper and easier to work; and this was probably due to the non-development of machine tools at that time. Machine work was largely a matter of sheet templates; drawings were almost unknown except as works of art, and the calliper was the recognised measuring instrument. Swiftly following this period came the general development of power-driven machines, and the rapid growth of engineering manufacturing works demanded more and better machine tools. The machine-tool industry became firmly fixed, and almost about this time the Springfield Co., of America, started the use of independent gauging. Then electrical machinery came into use, and in its wake numbers of new electrical manufacturing concerns were instituted all over the country. These firms in their early days were able to use mild steel, the telephone, electric driving and lighting, turret lathes, and early automatic machines; and, the author believes, were amongst the first to develop the use of drilling jigs, on large size work chiefly, owing to electrical machines being more easy of standardisation than previous engineering products.

Prior to this date the "toolmaker" was perhaps a man with a bench in the machine shop, whose sole duty was to repair chucks, "peg" broken gears, etc., and any machining he required was done in the general shop.

The electrical machine, however, necessitated the extensive manufacture of press tools, and gradually the tool room idea was developed, namely, to make tools entirely without intereference with production work. Unfortunately, like the pattern shop, the tool room appeared to have a non-productive aspect, because the goods it made were not directly saleable. The then works managers, therefore, would generally start reducing costs in that department when any criticism of works expenses arose.

The importance of the tool room grew but slowly until the introduction of high-speed steel, which again revolutionised shop practice. Then followed a rapid extension of the "closed-in" department, due probably to the fact that high-speed steel could not be worked upon by all. The milling machine and its cutters were developed, and cut gearing had to be used in machine tools. The grinding requirements of the cutters gradually evolved the tool store, and this, combined with the increasing use of jigs and the increasing importance of the tool room, made a tool drawing office absolutely essential. At about this date, say 1902, the automobile and petrol engine made its appearance, and again numerous new factories sprang up to take the fresh field of production. Gear hobbing and planing methods, the use of alloy and case-hardening steels, with the consequent development of the grinding machine, rapidly followed.

The grinding machine at once set a new standard of accuracy on all machine tools. With the exception of one pioneer firm in this country, which developed an entirely new line of machine tools, British machine-tool makers did not realise that a new era of production had set in, and in the new automobile factories scarcely any machine tools, except of American origin, were to be found. In these new works it soon became possible to work to required systems of limits, but at the outbreak of war only a small percentage of general engineering firms knew how to handle work containing a large number of parts which had to be produced to given limits of accuracy.

Effect of War Conditions on Engineering Practice.

The period of the war has seen another rapid development of engineering progress, namely, the manufacture of aero engines and planes, and they in their turn will exert an enormous effect upon the manufacturing methods even of the automobile firms.

The great problem ahead now is to settle the relationships and values between skilled, semi-skilled, and unskilled labour. There is every reason to believe that skilled workers will realise that their welfare eventually depends upon the maximum of production being obtained. Granted this condition, attained by means of a bonus system, or otherwise, successful production then depends upon two things only—organisation and special tools. The two go together, and one is useless without the other. Combine the two, and there is at once obtained the only desirable features of what America calls "scientific management."

(To be continued.)

Anchor Chain Co. Ltd. (156,202).—Private company. Registered June 19th. Capital £10,000, £1 shares. To acquire the business of ironfounders and mechanical engineers, etc., lately carried on by the late J. Eastwood under similar title at Lord Street, Oldham. Directors: A. Powell, J. Hasleden, and H. F. Hart. Office: Anchor Engineering Works, Lord Street, Oldham.

AN EPIDEMIC OF BAD FOUNDRY WORK.

If one thing is being more strongly urged than another to-day it is "production. In the engineering trades this is especially true, and the underlying reason is to provide plentiful supplies of commodities and reduce prices. The purpose of this article is to draw the attention of industrial engineers and others to a source of great expense in engineering production, and consequently more or less prohibitive costs for finished articles.

Many concerns to-day are getting seriously alarmed as to the high percentage of waste in castings. It is not a particularly happy state of affairs when a firm finds it necessary to order up double the requirements because it knows, from bitter experience, that at least 50 per cent will be faulty and unsuitable. In one works known to the writer the directors assured him that for two months past the amount of waste, so far as the bought castings were concerned, had risen to 75 per cent, which is a truly serious state of affairs. Enquiries in a number of other directions have revealed figures varying from 40 per cent to 60 per cent. If this were all, then these firms would know approximately where they were, but it is not, as a rule, until a certain amount of machinery has taken place that the defects begin to show themselves. That is to say, in addition to the number of castings that have to be scrapped there has got to be added the lost time both of the machine and the operator.

This state of affairs is particularly notorious in the motor car industry, and explains partly why progress in car production is so slow and prices so unduly high. No doubt other trades are meeting with the same difficulty, and if that is so, it is high time that the entire question should be carefully considered. Why there should be this epidemic of bad foundry work is not easily explainable, for we have reason to believe that during the war a satisfactory standard of quality was maintained. It may be that the present labour discontent has something to do with it, and that the reaction from war to peace time conditions is having its effect upon the foundry men. If this be so it is urgently necessary that some steps be taken in order to bring home to them the harm they are causing to the country's trade, the country itself, and eventually to themselves. For their own fortunes are bound up with those of their countrymen at large whether the latter be employers, shareholders, or traders.

A suggestion that might be taken up is that the Board of Trade should enquire into the matter and draw upon the experience of the Ministry of Munitions as to the causes and the remedy. At present private employers can do nothing, apparently, to improve matters, and are reluctantly compelled to put the wastage costs on to the finished article. But, obviously, if we are going to hold our own against foreign competition a complete change in the present system of foundry work must be brought about.

In many directions this problem was a vexatious one before the war. Large quantities of castings were brought into this country from Belgium, Switzerland, and elsewhere, not because they were cheaper than those that were being turned out in this country, but because the quality was more reliable. The writer of these lines had various opportunities of investigating the facts in pre-war days, and found that there were only too solid reasons for the charge against British products. As has been stated, there was good reason to believe that things had much improved during the war, but it really looks as if there had been a serious set-back. It is most essential that the subject should be publicly discussed and the responsibility for the trouble definitely allocated. Otherwise much damage will be done to the trade of the country.

Production is the life of the nation. It has to be developed in face of rising costs both for wages, direct and indirect, and for materials. How can it be increased if this other factor of waste is to be allowed to go on unchecked? At the moment no way out of the trouble is apparent. All that purchasers can do is to reject the "wasters" amongst the castings that are delivered to them, and decline to pay the foundry firms. The latter will have to deal with their own labour and make it clear that foundry proprietors and foundry men will sink together unless a change is rapidly forthcoming. We regret that labour is not rising to the occasion in spite of the greatly enhanced wages and shorter hours.

Here and there trade union leaders, like Mr. George H. Roberts, M.P., warn the rank and file of the consequences which may follow if the present policy of restricted output and poor quality of workmanship is persisted in. But it all seems to fall upon deaf ears, and large sections of the workers are busily engaged in repudiating their own leaders. Some aspects of the present labour upheaval are worth discussing separately, but what the country has got to face now, and probably for some time to come, is a restricted output, coupled with bad workmanship, which will hang like shackles upon the country's trade and commerce.

Messrs. Ed. Bennis and Co. Ltd., Little Hulton, Bolton, have compiled an interesting catalogue on their Self-Cleaning Compressed Air Furnace. This furnace, which is arranged for hand-firing, burns any class of fuel, large or small. Its chief claim is to burn with special advantage poor quality and refuse fuels. Considerable increase in steam output has been realised by many firms who use the furnace; at the same time it is a direct aid to economy, due to the fact that it enables them to burn rubbish of all descriptions with splendid results. We would advise anyone interested to write for a catalogue.

Combination in Belgian Metallurgical Industries.—The consolidation of interests in the Belgian glass industry has already been announced, and the movement appears to be taking root in other industries, says *The Board of Trade Journal.* According to the Press, a metallurgical trust, representing 300,000,000 fr. capital, is in process of formation. It is expected, in spite of the opposition of conflicting interests, that this will embrace the whole industry. After rebuilding and re-equipping existing works, the trust proposes to build three or four large factories, each specialising in the production of selected classes of goods.

Industrial Essay Competition.—Two hundred pounds are offered in prizes (£100 down to £5) by *Unity*, the organ of the National Alliance of Employers and Employed, for the best essay on either of the following subjects : A practical scheme for the joint development of industry by capital and labour; the most effective means for the prevention of unemployment; the most effective means for the prevention of industrial disputes. The above sum has been presented by Sir Robert Hadfield, and the Committee of Award consists of the Hon. F. Huth Jackson, P.C., the Master of Balliol College, Oxford, and the Right Hon. Arthur Henderson, P.C. The offices of *Unity* are at 64, Victoria Street, S.W. 1. Essays must not exceed 3,000 words in length, and must be received by August 30th.—*Electrical Review.*

Trade Items, Notes, &c.

Swiss Commercial Propaganda.—A Swiss Industrial Bureau has been formed at Lausanne. It has four main objects in view—to advertise Swiss industries, their productions or possibilities of production; to contribute to the re-establishment of normal economic relations between Switzerland and foreign countries; to develop exportation and exchange with the latter; to encourage collaboration between industrial managers, and to facilitate the creation and introduction of new industries.

Japanese Enterprise in Brazil.—Considerable interest has been aroused in Brazilian commercial circles by the visit to Brazil of the Vice-Chairman of the Chamber of Commerce of Tokio. He has visited the coffee districts of Ribeirao Preto, and other agricultural districts of the State of Sao Paulo, and has been received at a special session of the Rio de Janeiro Commercial Association, to which he was accompanied by the Japanese Minister In reply to a speech of welcome, he referred in eulogistic terms to the great future which Brazil offered as a market for Japanese manufactures, and stated that on his return to Japan he would endeavour to bring about a visit of Brazilian delegates to that country. The Japanese Minister also addressed the assembly, and, in the course of his speech, referred to the monthly service which Japanese steamers already maintained with Brazil, and which would shortly be increased. He also expressed great hopes as to the strengthening of commercial relations between the two countries, which would result from the opening of the branches of the Yokohama Specie Bank in Brazil, for which a charter had already been solicited from the Brazilian Government.—*Board of Trade Journal.*

Windmills in Denmark.—During the coal famine caused by the war many attempts were made to improve the working of windmills geared to dynamos to generate electricity. About 250 installations on farms and small estates have proved fairly satisfactory, according to *Ingeniören.* Many experiments in this connection were carried out by the late Mr. P. la Cour, and a trial mill designed by him is still being used for observation purposes. The following average results have been obtained :—

Velocity of wind (feet per second).	Power obtained in kilowatts.	Number of hours useful wind.	Total kilowatts per annum.
16·4 feet	3·1	1,796	5,600
19·6 feet	6·0	1,080	6,500
23·0 feet	10 0	900	9,800
26·2 feet and above... ...	13·0	1,945	25,100
	Total ...	5,721	47,000

During about one-third of the year there was either complete absence or excess of wind, and the force available was very variable. It was nevertheless found possible to save fuel for steam or gas-driven power producers. The cost per kilowatt from peat gas-fired plants is approximately the same as from a windmill-driven installation. Attempts were made to design three-phase dynamos capable of maintaining constant voltage independent of the speed of the mill, special attention being also paid to automatic adjustment of the sails in order to reduce the cost of attendance. A mechanical contrivance affects a turning movement of the sails, so that during very high winds these occupy a position parallel to the direction of the wind, thus avoiding damage to the mill. Attention has also been paid to gearing and bearings to minimise losses in transmission from the sails to the dynamo.—*Journal of Society of Arts.*

The plant which the Hampstead Council proposes to erect to deal with the house refuse collected in the district comprises a rotary hexagonal screen, 5ft. 6in. across the flats and 14 ft. long. For 8 ft. 6 in. of its length it will be fitted with $\frac{3}{8}$-in. perforations, and the remaining 5 ft. 6 in. with 2-in. perforations. The fines go into a pit, from which they are passed by an elevator into trucks on the siding alongside. The coarser material passing the screen is discharged into a washer, which separates the fuel from the débris. The remaining material falls on to a picking belt, along each side of which stands pickers picking out metals, bottles, bones, and other material which it is desired to salve. Any remaining material which is not picked out is delivered into a disintegrator, which pulverises it, and is discharged into the same pit which receives the fine screenings. The whole plant will be operated by electric motors. The estimated cost of the plant complete amounts to £6,700.

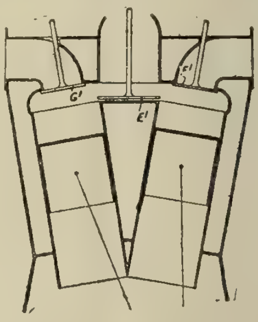
Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

INTERNAL-COMBUSTION ENGINES.

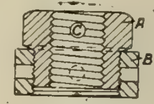
120,613.—H. R. Ricardo, 21, Suffolk Street, Pall Mall, London,—Nov. 13th, 1917.—The distribution of the charges in an engine having a pair of inclined cylinders with a common combustion space is controlled by a centrally-disposed inlet valve E1 and a



pair of exhaust valves F1, G1, all of large diameter. The valves are actuated by an overhead cam-shaft, the inlet valve directly and the other valves indirectly. Pairs of cylinders may be arranged around the crank-shaft.

LOCKING NUTS.

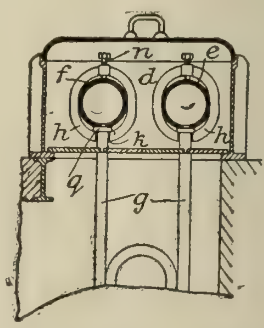
120,642.—J. E. Rogers, 65, Claremont Road, Smethwick, Staffordshire.—Nov. 27th, 1917.—Relates to nuts of the kind which are reduced for a part of their length to a diameter slightly less than that across the flats, this reduced part being screwed with a left-hand thread, if the nut is an ordinary right-handed one,



to receive a nut or collar B of slightly greater thickness than the length of the reduced part and consists in making in the upper nut A a hole C to receive a cotter pin which passes through a hole in the bolt to lock the nuts in position after adjustment.

STEAM-SUPERHEATERS.

120,656.—H. A. Hewat, 167, St. Vincent Street, Glasgow.—Dec. 12th, 1917.—An element *g* is connected to the bottom of horizontal parallel headers *e*, *f* by clamps *h*, each encircling a header and gripping the element so as to pull it against its opening in the header. A gap *k* in the bottom of each of the oval-shaped clamps

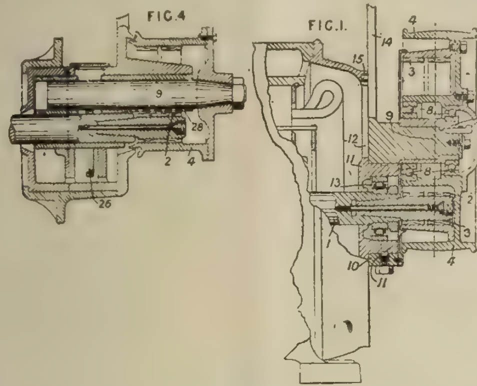


shown has stiffening jaws adapted to be pressed against a collar *q* on a tube end by a screwed bolt *n* screwing into the top of the clamp and bearing against a header. The headers are enclosed in a box *d* packed with slag wool, asbestos shavings, or other non-conducting material.

REDUCTION GEARING.

120,672.—P. A. H. Mossay, 322, Norwich Road, Ipswich.—Jan. 26th, 1918.—Relates to reduction gearing for electro-motors and other motors used to drive compressors, pumps, vehicles, etc., and of the kind wherein a belt pulley, friction wheel, or toothed wheel is driven by a tothed wheel on the motor shaft gearing with an annular wheel and supported on a bearing eccentric to the motor shaft, the bearing being adjustable round the motor shaft to enable a driving-belt to be tightened or a toothed or friction wheel

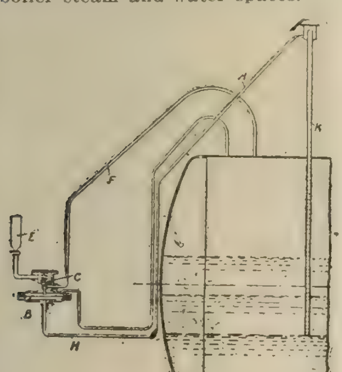
to be connected or disconnected. According to the invention, the wheel on the motor shaft and the annular wheel are of double-helical type, and means are provided for lubricating the gearing and facilitating the assemblage of its parts. In the form shown in Fig. 1, the shaft 1 of the electromotor is mounted in roller



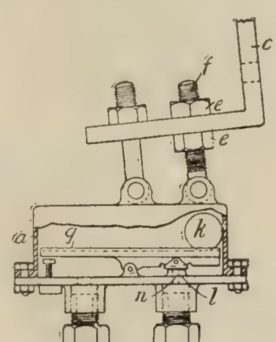
bearings 13, and carries in its end a double-helical pinion 2 which gears with an internally-toothed rim 3 fixed inside the pulley 4. The pulley 4 is mounted on ball bearings 8 on a pin 9 carried by a sleeve 10, which may be rotated by a lever 14 about a cylindrical boss 11 on the casing 12 of the motor, to enable the tension of the belt to be adjusted. A pin 15 on the lever 14 engaging holes in the motor casing, or a ratchet, enables the pulley to be held in any position. The toothed rim 3 may be disengaged from the pinion 2 by rotating the eccentric bush 31 or by disconnecting the rim from the pulley. A modified means of supporting the pulley independently of the motor shaft is described. In the form shown in Fig. 4, the roller and ball bearings are omitted, the motor spindle is lubricated by a ring 26, and the pulley spindle 9 is lubricated by oil by the pinion 2 through holes 28. The spindle 9 and the motor spindle may both be lubricated by rings, and the pulley 4 may form a reservoir for lubricant.

STEAM GENERATORS.

120,705.—H. W. SPENCER, 147, Queen Victoria Street, London, and R. CLARK, 17, Burlington Avenue, Kew Gardens, Surrey.—June 24th, 1918.—In alarm apparatus in which the operation of the alarm is controlled by a daphragm B in a chamber in communication on one side of the diaphragm with the boiler steam space and on the other side with a stand pipe K extending into the boiler to the low or high water level, the steam for sounding the alarm is taken directly from the boiler through a pipe F. In the low-water alarm apparatus shown, when the water level falls below the bottom of the stand pipe, the pipe empties, and the unbalanced weight of the water in the pipe connection H raises the diaphragm, which opens the valve C between the end of the steam pipe F and the whistle E. In high-water alarm apparatus, the stand pipe, which is normally open to the steam space, fills with water when the level rises, and the valve C is adapted to be opened by the depression of the diaphragm by the steam pressure acting on its upper surface. The two alarms may have a common boiler connection for supplying steam to the whistles. The stand pipes may dip into a vessel in communication with the boiler steam and water spaces.



Patent 120,705.



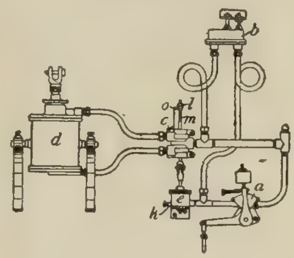
Patent 120,767.

SPEED GOVERNORS.

120,767.—T. JACKSON, 27, Mount Pleasant Road, Lewisham, London, and A. RAMSAY, Chesham, Sandgate Road, Folkestone.—Nov. 20th, 1917.—A marine-engine governor comprises a casing *a* adjustably attached to a fixed bracket *c* and enclosing a tiltable member *g* carrying a mobile body *k*, which, by rolling along the member *g* operates a valve *l* and allows pressure fluid to pass through a port *n* to a fluid-pressure relay controlling the throttle valve, etc. The inclination of the box *a* can be adjusted by means of a screwed rod *f* and nuts *e*.

SPEED GOVERNORS.

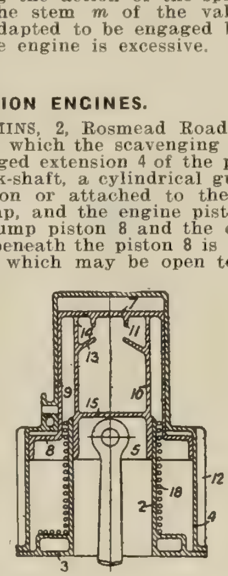
120,768.—T. JACKSON, 27, Mount Pleasant Road, Lewisham, London, and A. RAMSAY, Chesham, Sandgate Road, Folkestone.—Nov. 20th, 1917.—In a governing-apparatus for marine engines, comprising a fluid-pressure power device *d* for operating the throttle valve, a valve device *c* for controlling the power device, and an inertia governor *a* operated by the engine and/or a governor *b* of the tiltable gravity-controlled type having a mobile body and operated by the movement of the ship, a relay power



device *e* operates the valve *c* and is controlled by either or both the governors *a*, *b*. The governor *a* may be of the kind described in Specification 13,019/14, and the governor *b* of the kind described in Specification 120,767. The relay cylinder *e* has an adjustable valve *k* for regulating the action of the spring-controlled piston in the cylinder. The stem *m* of the valve *c* may carry an adjustable collar *l* adapted to be engaged by a spring detent *o* when the speed of the engine is excessive. Specification 14,459/07 also is referred to.

INTERNAL-COMBUSTION ENGINES.

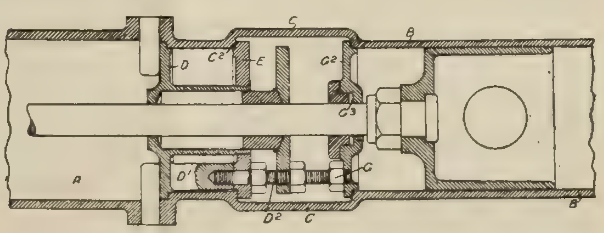
120,769.—W. R. CUMMINS, 2, Rosmead Road, London.—Nov. 21st, 1917.—In an engine in which the scavenging or explosive mixture pump forms an enlarged extension 4 of the power cylinder at the end nearest the crank-shaft, a cylindrical guide 2 for the engine cross-head 5 is cast on or attached to the cover 3 closing the front end of the pump, and the engine piston 7 is connected by trunks 9, 10 to the pump piston 8 and the cross-head 5. On the out-stroke, air from beneath the piston 8 is forced through ports 14 into the trunk 10, which may be open to the atmosphere or



closed by a partition 15. Cooling-ribs 11, 13 are formed on the piston head and the trunk 10, and water or other cooling medium may be circulated in a coiled tube 18 or in a jacket surrounding th guide 2. Cooling-ribs 12 may be formed on the outside of the pump 4, or on the cover 3 or the inner surface of the trunk 9. Instead of the ribs 11, 13, tubes of copper, iron, or other material may be fixed in the piston crown 7. The pump piston 8 and the trunks 9, 10 may be in one piece, to which the piston crown 7 and the cross-head 5 are secured by bolts or other means. Specification 29,183/09 is referred to.

STEAM-ENGINES.

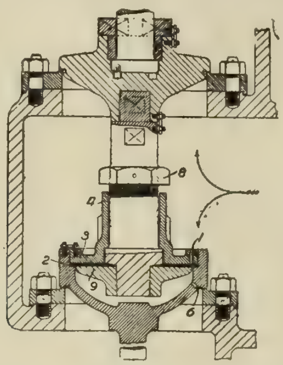
120,779.—S. E. ALLEY, 33, Tothill Street, Westminster.—Nov. 24th, 1917.—The cylinder A and cross-head guide B are connected by a bridge-piece C formed integral therewith. The cylinder cover D is inserted from the rear and is provided with projections D1



for studs D2, the nuts upon which engage an annular flange E engaging a shoulder C2 on the piece C to hold the cover in position. Alternatively, the cover may be screwed into position. The cover D is provided with a stuffing-box, and a closure plate G2 provided with a stuffing-box G3 is also held in position by nuts G on the studs. The parts E, G2, etc., are inserted through a door in the piece C.

VALVES.

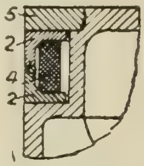
120,845.—Cockburns Ltd., D. Cockburn, and D. MacNicoll, Cardonald, near Glasgow.—Mar. 28th, 1918.—A double-beat valve, of the kind in which one beat is attached to the spindle by means of a diaphragm 1 imprisoned in a cell formed between the valve member 2 and a covering-member 3, has the valve member pro-



vided with a port 6 to admit outlet pressure beneath the diaphragm, and has a nut 8 on the spindle adapted to engage a sleeve 4 on the covering member to clamp the diaphragm between a backing-plate 9 and the member 3 to facilitate the simultaneous grinding of both valve members.

PISTON PACKING.

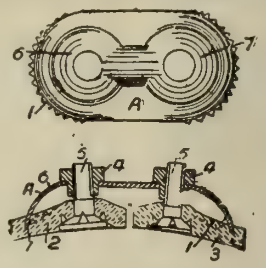
120,959.—W. H. Smith, Eccleston Mill, Prescot, Lancashire.—Nov. 26th, 1917.—A pair of split-rings 2 of L-section are expanded by a split-ring 4 of rectangular cross-section, preferably of steel.



The internal angle of the rings 2 is bevelled, as shown, in order that the packing may be pressed axially as well as radially. The packing is secured by a junk-ring 5.

DRIVING-BELT FASTENINGS.

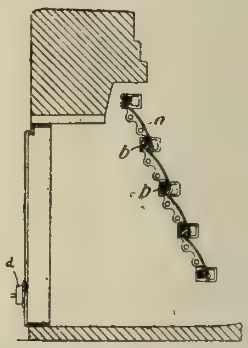
121,002.—T. E. Morris, The White Swan Inn, Church Street, and H. Bagnall, 3, West Bromwich Street, both in Oldbury, Worcestershire.—Dec. 15th 1917.—An oblong bridge-piece A secured by bolts and nuts 4, 5 is provided with projecting teeth



1 at the ends which penetrate the ends 2, 3 of the belt, and with domed projections 6, 7 round the bolt-holes. The bridge-piece may be stamped from sheet metal and may be rectangular, and two or more parts each similar to A may be formed in one piece for use with wide belts.

FURNACES.

121,018.—A. Meade, Kelmscott, Hardy Road, Blackheath, London.—Jan. 14th 1918.—An inclined grate is formed of hanger bars *a* depending from cross-bars *b*. The lower ends of the bars



of each row come between the upper ends of the bars of the row below, the lower ends resting against prismatic portions of the cross-bar from which the lower row of bars is suspended.

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CONTENTS.

EDITORIAL.

EXPERT COMMONSENSE.

SOME short while ago, in a discussion which involved possible reconstruction of one section of a large organisation; the chief said to one capable man, "Suppose you were instructed to take over that section?" the reply was a confession of want of expert knowledge, with the addition, "I could only apply ordinary intelligence and commonsense;" the chief's comment, pointed by specific example, was, "Those qualities are not quite so common as you infer."

The conversation is chosen to illustrate the fact that expert knowledge is often accompanied by a corresponding lack, the wood being hidden by the trees. It is a commonplace of legal procedure that although judge and counsel are expert, decision is imposed upon twelve good men and true chosen haphazard, and minus legal experience.

After all, it is the results of expert knowledge, especially in industrial matters, which count, yet it is a general tribunal which approve or reject; there is a commercial as well as a technical aspect to production, a practical view as well as a scientific. They have all a place in the scheme of things entire, but are dependent, not independent of each other.

Perhaps the worst general manager is one of narrow technicality, of specialist type he has lost the general public man in the street standpoint, and is prone to push his profound knowledge of a single section to the detriment of the rest. Acting in a technical capacity this is quite correct, acting in an administrative capacity it hampers and impedes. Nearly every works manager has a local weakness for one section of his charge; he is apt to spend more freely, support more strongly, and take a more vital interest in what becomes a protege; where affection blinds it warps judgment. In a works of assorted character the boiler shop or foundry are often the cinderella of the concern; it is very rarely the machine shop, at all events nowadays. Yet it pays to foster the most usually neglected, and to apply special attention and time, to say nothing of sanctified commonsense, to such offspring. Even apparent interest does much, and real attention more, to give results; concentration upon outlying frontiers should make the capital more secure.

An engineering works which combines the whole cosmos of production is a kingdom with very complex racial problems, it is insufficient to deal with positive trouble when it arises, it is much more necessary to anticipate and forestall. For some unknown reason boilermaking, when in association with related trades, seems most neglected, yet nothing pays for shrewd capital expenditure more surely than the trade which used to be described as a combination of brute strength and low intelligence.

The self-contained firm has the advantage of control over all its production, but suffers the disadvantage of being unable to locate with exactitude its weak places; its only standard of comparison is the overall price at which it can market its product in competition.

Intuitive insight is more often a case of asking commonsense questions and weighing the answers in the light of intelligence than a matter of special temperament; while improvement is more a matter of striving after its spirit, willing to alter in the light of reason and understanding, than a divine gift bestowed fortuitously. Boilermaking is an outstanding example, where the best is the most

cheaply made; good work demands first-class equipment, and some scientific commonsense. Badly-made boilers are so made with infinite difficulty by archaic methods; good boilers are made where the least handwork is evident. The refinement and exactitude common in the machine shop can be transferred with real saving benefit to the boiler shop, and there is room for improvement in even the best shops extant. Boilers should be fabricated rather than built, and there are few firms who have learnt the lesson.

The point is, that the more expert the boilermaker as an individual, the more he is able to compensate for initial error and bad process, the worse his product. Commonsense and modern methods hand in hand have increased production; given an infinitely better product, whose evolution has been opposed at every stage by vested skill. In other words, since the trade was revised from outside it owes nothing to the expert of its own creation; he was unable to visualise progress inevitable in its trend and reaction. Without pressing the comment of a certain learned judge who classified the perjured occupants of the witness box in grades as liars, d—— liars, and expert witnesses, there is some ground for investigation even where the expert is experienced. In so far as he has had to sink his overall commonsense to obtain his expertness, he is less qualified by warpage in the process.

It is common knowledge that the expert must be a specialist, and the more specialised he is the less able is he to occupy a post demanding co-ordination; in gaining his knowledge he has lost in general ability *pro rata*. Hence few technicians have whole mentality.

To enter a plea for a wider scope in productive training does not infer retrogression; it should promote progress; it is evolution of industry, not the simple enhancement of single sections, which makes for industrial health. If the example chosen is outstanding, the argument is not vitiated thereby.

"GOLDEN WALKERITE" JOINTING.

COMPRESSED ASBESTOS SHEETS.

Written and Illustrated by James Scott.

That things are not always what they seem to be is a truth capable of being continually demonstrated, especially in industrial circles. The prevalence of wrong opinions concerning many classes of goods which are used to a very large extent by engineers is quite remarkable. Superficial examination is often responsible for such mistaken ideas, and these ought not to be formed in the absence of reliable, confirmatory tests, whatever likeness they may bear to other substances.

I have written in this strain because of the fact that the special material which I have taken for consideration on this occasion, viz., an example of compressed asbestos sheet jointing, presents, superficially, a very different appearance from that of its true nature. It is called "Golden Walkerite" jointing, and is manufactured by Messrs. James Walker and Co. Ltd., "Lion" Works, Garford Street, West India Dock Road, London, E. 14.

It resembles simply sheets of gilded cardboard of a pliable character. This is what the casual observer would probably call it if he judged it solely by means of his limited knowledge and experience. Yet it is a far more elaborate and valuable a commodity than common cardboard could be, however carefully it was treated.

Seeing that the practical man will be perfectly acquainted with every requirement connected with this product, I will confine my remarks to a close inspection of its formation from my own point of view, and not enter into details in regard to its particular working service. Engineers who have hitherto rejected this class of jointing owing to mere suppositions devoid of genuine foundation will have lost beneficial attributes, while those who have proved its value will find hereafter outlined the reasons why this course of events was possible. The subject, although it does not yield any striking spectacles, is not altogether too meagre for close attention, as I hope to show. This jointing is eminently suitable for use in cases where acids, ammonia, gases, hydraulics, high pressures, superheated steam, and

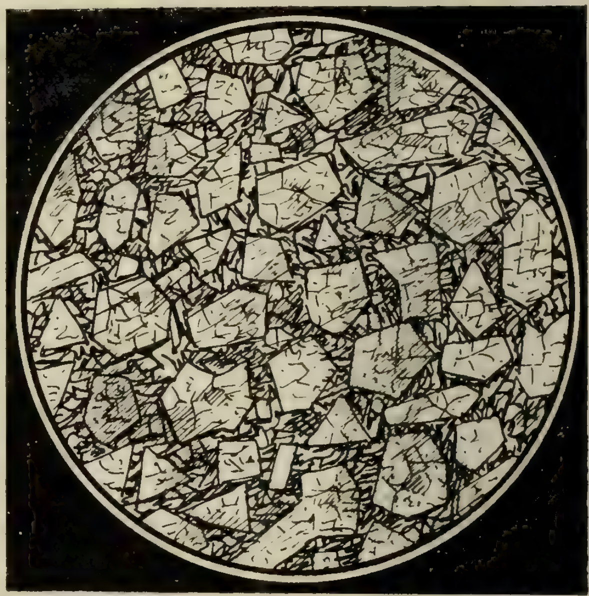


Fig. 1.—One-twenty-fourth inch of the gilt surface of "Golden Walkerite" Jointing for superheated steam, etc. (magnified). It is composed of compressed asbestos.

petrol are regular accompaniments, since it has been prepared to withstand the action of these powerful forces and substances.

Too many men conclude that if they can readily tear a jointing it must be weak, and therefore not possess the qualities and properties needed on its behalf; but they do an injustice in this direction, as the chemical advantages, while not obvious until they are put into practice, offset this tendency. To exclude this kind of jointing solely on account of tearing capacity is, in a sense, ridiculous, and is based on false notions about its fibrous formation. One is quite right to think that if it was only what some people regard it as—that is to say, a variety of very thick paper or cardboard—it would not be of much good for the purpose for which it is made. But apart from its inherent chemical indestructibility its fibres wear better than would those of wood, esparto grass, cotton, hemp, linen, and so on, as used for the basis of ordinary paper.

You may have a jointing that will absolutely resist all attempts to tear it, yet it will gradually disintegrate, when fitted into active position, in an engine or machine because its chemical constitution is without the advantages possessed by a tearable jointing. In use the latter, providing it is of genuine constitution to begin with, outlasts, as a rule, the former.

Upon tearing a sample of this jointing into narrow strips one can observe what seem to be plain, raw, rough edges where the fibres have been torn apart, or, as is more accurately the case, separated from one another, as the fibres do not actually break.

Certainly they have a very close similarity to plain brown cardboard; but if one of these edges is held in a flame—preferably a spirit flame, which is clean—the projecting fibres soon become red or white hot, and although they glow intensely, do not get consumed. Indeed, they continue to stand out clear, brilliant, and undisturbed, without losing an appreciable proportion of their bulk. When they are cooled again they are found to be essentially the same, bar the faint exceptions mentioned hereafter, as they were before being heated.

Do the same with prosaic cardboard, and note how rapidly it is consumed into a shapeless ash which falls apart at the slightest touch; yet cardboard can, in some processes, be so treated as to resist tearing influences.

If the heated fibres of the jointing are magnified while they are in their incandescent state—and to do this I place the tube of my microscope horizontal and thus look through it—minute scraps of the thinner ones can be seen flying off occasionally; but this effect is due to the moving action of the flame, which, of course, is comparable to draught (except in regard to temperature), which by the progressive impingement against the stationary particles forcibly snaps some of them off, and causes them to be carried away. These details cannot, however, be seen with the naked eye.

The glowing edge fibres are shown in Fig. 2, and it should be borne in mind that most of these are ordinarily invisible, only the thicker members being seen without optical aid as slender shreds. It is plain that if such small items can withstand the treatment referred to the whole mass of material has the same attributes conferred on it million-fold.

It is too widely believed that asbestos is nothing more than a prepared material. Fabrics and sheets made of it are so deceptive that many persons regard them as just ordinary woven or compressed fibres treated with a fireproofing medium. But they are wrong. It is, on the other hand, in its crude condition a rock, and is dug up or mined in lumps which are subsequently ground to a fibrous, fluffy powder. If we handle a piece of the mineral, it resembles, and practically is, a hard stone with a longitudinal grain running through it. By hammering it can be broken up into thick sticks, and these can be pulled apart into splinters. The latter can then be rubbed down into fibres; and so curious is the structure that you can pick a fibre apart into fibrils so tiny that they have to be magnified before they can be seen.

After having had impurities removed from it, the asbestos as it occurs in a woven or compressed state—that is, as either fabric or board—is precisely the same as it existed in the earth, except that it is split apart into its component fibres. For this reason it cannot be burnt, nor can it be melted by the tempera-

FIG. 2.—One-twenty-fourth inch of the torn edge of "Golden Walkerite" Jointing in an incandescent test, showing the indestructible fibres (magnified).

tures normal to most industrial work. The natural colours of asbestos are white, grey, and blue. That is why, although the parts of this jointing which have been heated to incandescence are ash-like, this is really a discolouration, and does not indicate a residue from combustion.

The magnified golden surface of the jointing is

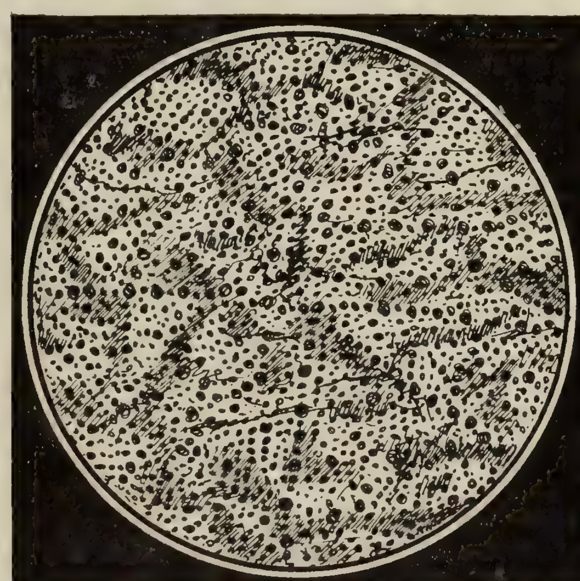


FIG. 3.—One-twenty-fourth inch of the straight-cut even edge of "Golden Walkerite" Jointing (seen at right angles to the surface) showing the porous character (magnified).

shown in Fig. 1, the particles being semi-crystalline and interesting; but they are not entitled to so much consideration as the fibres. These glistening objects

are separately detached on the finger tips when the jointing is handled.

Gold powder is produced by a variety of extremely different methods, and the results of some of them would not be of a proper nature for use in jointing, so that even in this minor direction we find that the substance selected for experiment has a desirable merit.

In Fig. 3 is shown the magnified formation of the jointing as viewed along a sharply cut edge of it. That is, it is a section cut across the fibres, and seen transversely or longitudinally at right angles to the surface. A torn edge thus examined from apices of the fibres would be too frayed to reveal anything worth notice. The pores indicate tiny connecting interstices between the entangled fibres, and these are occupied by the lubricating ingredients and other necessary composition. Asbestos fibres themselves are like a species of glass, and cannot absorb liquids, which have to lie in the spaces between them.

It must be clearly understood that, although we can set light to this jointing, and get an abundance of flame and smoke, it is not the fundamental fibres which burn, but the lubricating, oily, and kindred matter which is incorporated among them

OIL SHALES.

(*Continued from page 424.*)

The richest oil-shales in the United States belong to the Green River formation of Eocene age, and are to be found in Colorado, Utah, and Wyoming, but these are by no means the only shales which will yield oil when distilled. The Devonian black shales, for instance, which underlie great areas in the eastern part of this nation, are in most places oil-yielding, but the amount of oil that they will yield may be too small to allow their commercial development. Only a very rough reconnaissance study of these shales has been made, and it is not at all certain that more careful search in Indiana, Ohio, New York, Pennsylvania, Kentucky and Tennessee will not disclose areas where the shales of this age are sufficiently rich to warrant their being worked. In general the oil-shales of these older geologic formations have the same characteristics as the oil-shales of the Green River formation.

Cannel coals are as a rule capable of producing a goodly quantity of oil when subjected to distillation, and where the cannel coal is so high in ash as to prevent its use as a grate fuel, it is well worth while to consider the mining and distilling of such material for its oil and ammonia values. The bony coal which is found in connection with some of the bituminous coals, may also be worthy of consideration, although this kind of material will probably yield very heavy oil or tar when distilled.

In western Montana, certain dark shales belonging to the older formations (Upper Paleozoic age), have been found to yield a moderate amount of oil when distilled, and in addition some of these shales contain phosphate, an element which is much in demand for its fertilizing value. If the phosphate in these shales is in some form that can easily be made usable, it is quite possible that these shales can be treated jointly for their phosphate and oil values at a profit, but it is certain that the cost of operating them for their oil alone will be prohibitive.

A broad field is open to those interested to determine what substances there are in the United States which are capable of yielding liquid oil products when distilled. The Germans have for many years been distilling lignites, and perhaps our own lignite of North Dakota and Montana, as well as Texas and the Gulf Coast States, will find a market through this channel. It is certain that many of the "fatty" lignites are worthy of investigation with this in view. Experiments are already being carried on to determine the possibilities of the North Dakota lignites as oil producers.

Organic deposits like oil-shale and coal contain a considerable percentage of nitrogen, and the successful development of oil-shale may depend largely upon the economical recovery not only of the oil but the nitrogen of the shale. Recent analysis of nearly two hundred samples of oil-shale has uncovered the fact that American oil-shale is different from the Scottish oil-shale in that in the oil-shale of the Green River formation the percentage of nitrogen increases with the richness of the shale. It is reported that in the shale being mined in Scotland, the shales richest in oil are poorest in nitrogen. Although the percentage of nitrogen in the oil-shales of the Green River formation of Colorado is not as great as the percentage in ordinary coal, the recovery of this valuable element, will add only a small cost to the process of treatment in proporation to its value.

We in America have never been driven to the development of our natural resources to the extent of many of the other nations of the globe. In Japan, for instance, the people are forced to artificially terrace the rocky mountain sides in order to make room to grow sufficient farm and garden products to maintain the populations of the islands. In Scotland no petroleum has been found, and the people long ago perfected processes for extracting oil from the oil-shales of their territory, and for more than sixty years there has been an industry in Scotland which has supplied much of the oil needed for its industries. In each of these places the people have risen to the occasion, and have devised means to provide the necessities from the materials at hand. Records show that in Scotland the shale treated averages only about twenty-four gallons (little more than half a barrel) of oil per ton of shale. What the Scot can do with this medium grade oil-shale, we surely can do with a shale which will yield perhaps twice as much oil if not more.

Within the past five years numerous individuals and companies have devoted a great deal of attention to the oil-shales of the western part of the United States. Much of the more favourably located land has been filed on as mineral land under the mining laws of the nation, and in a few cases the Government has actually asked to transfer the patent to this land to private individuals. Several of the companies are carrying on extensive chemical and engineering research, looking toward the development of efficient and practical processes, and machinery for getting the oil and other valuable products from the shale, and at the present time there are at least a score of different processes proposed and partly

perfected for the distillation of oil-shale. Many of these are doubtless destined for discard, not because they fail to produce the shale-oil, but because they either will not produce the right kind of shale-oil or the oil produced will cost more than it can be sold for.

The United States Bureau of Mines is conducting experiments and investigations looking toward the utilisation of the oil-yielding shales of the western states, but it will necessarily be some time before the results of this work can be published.

During my own field studies of the oil-shale for the United States Geological Survey in the last five years I have found it of great value to the work to make distillation tests of samples of oil-shale in the field, and for his purpose I have carried with me a small apparatus in which I could heat a weighted amount of crushed shale and condense the vapours which were formed and measure the resulting distillate. This apparatus consisted simply in a small (half-pint) iron retort connected to a simple all metal water-cooled condenser. Heat was furnished by a small gasoline plumber's torch, and the distillates were measured in a glass graduate. Crude as was this field apparatus I have found that it was possible to vary to a remarkable degree the kind of oil that would be derived simply by changing the quantity of heat used, and no doubt if it had been possible to vary other conditions pertaining to the distillation, such as pressure, etc., additional variations in the product would have resulted. For instance, if I rapidly increased the temperature of the shale till it was heated to red heat I got a very different character and quantity of oil than that received when early in the treatment I raised the temperature very slowly. If a slight manipulation of the conditions of heating in this crude apparatus will make such a difference in the character of the product, then it seems that until we have shale-oil produced in a commercial plant there is little value in having a chemist determine carefully the characteristics of shale-oil. This is the more important when it is realised that no two of the many processes that are being proposed for oil-shale distillation are designed to subject the shale to the same conditions. As soon as there is in this country a commercial plant for the production of shale-oil we can find out what shale-oil is, and how it compares with the petroleum of the various oilfields. Roughly, I believe that it is safe to prophesy that the shale-oil of the future will yield on refinement products that are quite similar to those that are manufactured from ordinary petroleum, but until we know what the shale-oil is and what it will produce it is obvious that no one can state in more than general terms what will be its value in dollars and cents. I will not be at all surprised to see products not now produced from oil-well petroleum developed commercially from shale-oil.

The shale-oil that has been produced in the Scottish oil-shale industry is a thick green oil which at ordinary temperatures has much of the consistency of vaseline, and if the oil that is to be produced from our own oil-shales is similar to that made in Scotland, we must devise other means than pipe lines for transporting it from place to place. Fractional distillation of the shale-oil that was produced in the small testing apparatus used in my own field examinations, gave about 12 per cent gasoline and 35 per cent kerosene, with as much as 9 per cent paraffin. These figures are not at all complete or final, but they serve to give us a general idea of the character of shale-oil.

(To be continued.)

DESCRIPTION OF THE WILD-BARFIELD ELECTRIC FURNACE EQUIPMENT.

The furnace consists of a chamber which is wound with a heating coil of wire. The chamber is surrounded by a special lagging powder and is contained within an outer casing of refractory material. The chamber holds a mixture of fused salts ("Thermolite") having a freezing point of 685 deg. Cen. The outer casing is wound with an enamel-

Complete outfit on bench.

covered copper wire, and this outer coil constitutes the pyroscopic detector.

A special device called the compensator is connected in series with the pyroscopic detector coil, and the circuit is completed by coupling up to an instrument called the pyroscopic indicator. The type of indicator employed depends upon whether the furnace is to be used on direct or alternating current. On alternating current the furnace winding constitutes the primary and the detector winding the secondary of a quadrature transformer. The compensator is simply a second quadrature transformer, which is adjusted to have exactly the same coefficient of inductance as the furnace.

The detector winding and the secondary winding of the compensator are coupled so that their respective E.M.F.'s are in opposition. Thus normally no current flows through the indicator. As soon, how-

ever, as a piece of iron or steel is introduced into the furnace, the voltage of the detector winding is increased, and a current flows through the indicator, which is shown by a deflection of the needle up the scale of the instrument.

When the iron or steel reaches the temperature of decalescence it becomes non-magnetic. The needle of indicator then at once returns to zero. The steel is then known to be at exactly the right temperature for quenching.

On direct current there is normally no voltage induced in the detector winding so long as the current is absolutely steady. The compensator is, however, still required to neutralise the transient effects of fluctuation of the current.

On introducing a piece of steel into the furnace only a momentary deflection is obtained, the indicator quickly returning to zero. When, however, the steel arrives at the critical temperature an unidirectional current is induced in the detector winding and a deflection in the indicator is obtained, which starts from the time that the steel begins to

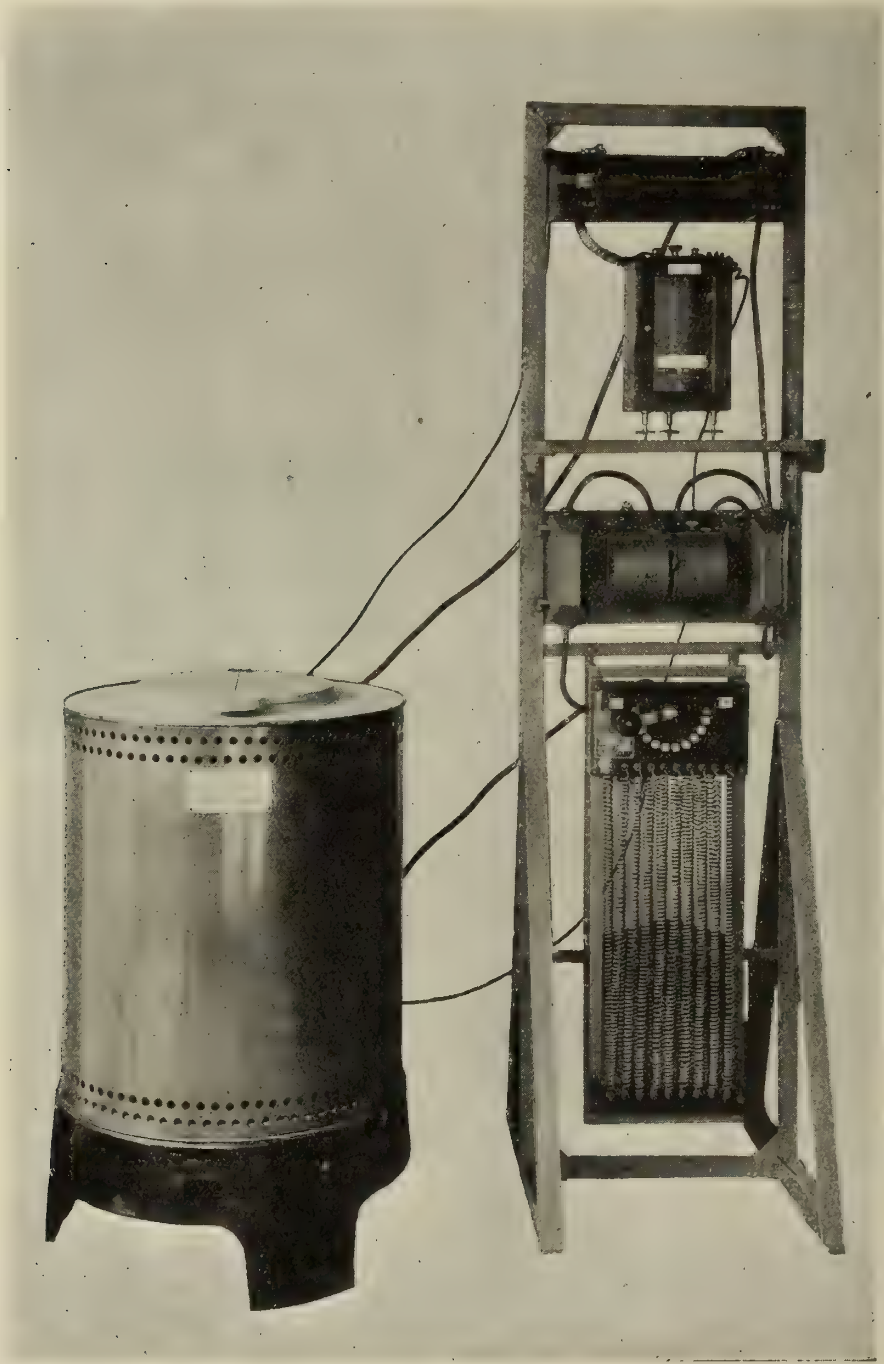


Illustration of 12 in. Furnace on cast-iron stand|c›mplete with Regulating Resistances, Change Point Indicator, Swit·h Fuses, &c., on angle-iron switchboard.

lose its magnetism and endures till all magnetism is lost.

As soon as the indicator has returned quite to zero the steel is known to have reached the right temperature for quenching.

In practice it is customary to run the furnace at a temperature of 800 deg. to 850 deg. Cen., which is considerably higher than the critical temperature of any carbon steel. The steel then heats up very quickly and there is no time for decarbonisation of the surface, and no time for deformation, due to flow of metal to take place; little attention need be paid to the absolute temperature of the furnace, for as soon as the steel itself arrives at the right temperature the indication is given, and the operator is informed of the right moment to withdraw the steel and quench, cool in air or otherwise complete the operation.

The furnace may be used for the purpose of determining the critical point of any carbon steel. In addition, by using a bundle of iron wire in the furnace, any pyrometer can be easily checked for accuracy, the magnetic change point of iron being fixed and known with a high degree of accuracy.

Articles to be heated in the furnace may be treated singly if of large bulk, or may be treated in batches so long as all articles in a batch are of the same size and of the same steel, it being only necessary to secure sufficient separation of the articles, so that in quenching all may be cooled evenly.

The furnace may be employed for the treatment of cased steel. The steel having been cased first in any ordinary way, the core may be refined in the furnace, using a reliable pyrometer for this operation. It should then be re-heated and quenched for the case, using the pyroscopic indicator to determine the moment of quenching. The quick heating obtained in this second operation prevents deterioration of the core, which would certainly take place if the steel were soaked for a lengthy period.

Wild-Barfield furnaces are supplied in various sizes and types, and the following table gives full particulars of output, current consumption, &c.:—

Diameter of Furnace in inches	2	3	4	6	8	12
Maximum length of article in inches ...	8	8	8	10	12	18
Maximum weight of article in lbs.	½	1	2	4	10	30
Pounds of Steel per week of 47 hrs. that can be hardened	235	352	470	845	1400	3050
Maximum current consumption in watts ...	700	1000	1400	2600	4200	9500

From the above table it is a very simple matter to compute the cost of current. As an example we may say that with electric current at one penny per unit the cost of power comes out to £3 13s. 6d. per ton of steel treated.

Dr. Samuel Smiles, of University College, London, has been appointed to the new chair of organic chemistry of the Armstrong College, Newcastle-on-Tyne.

THE WORLD'S SHIPPING.

Lloyd's Register for 1919-1920.

The new edition of "Lloyd's Register of Shipping" for 1919-20 is of much interest. It is the first issued entirely free from censorship since war began. The main body of the Register, which contains particulars of all sea-going vessels of 100 tons and upwards, has been carefully revised and brought up to date, and the complete elimination of all concealment as regards losses enables the Register again to become the most reliable authority on merchant shipping published.

The work contains once more, in all their completeness, the several auxiliary sections, including, in addition to a directory of shipowners and managers, with lists of their respective fleets, particulars of vessels fitted with refrigerating appliances, vessels fitted for carrying petroleum in bulk, cable steamers, motor vessels, and those fitted for burning oil fuel; detailed information upon such matters as docks, tidal harbours, etc., in all parts of the world, telegraphic addresses of firms connected with shipping, lists of shipbuilders, steamers arranged according to tonnage, and fast merchant steamers. A new section has been provided giving the deadweight capacities of steamers and motor vessels, which will prove of great practical value. But, necessary as all these records are to the business man, the section which will prove of greatest public interest is the one giving the new statistical tables. These provide not only particulars of the tonnage now owned in each country of the world, but also the necessary information for comparison with similar figures issued in 1914, and thus allow of a fairly accurate estimate of the effect of the war on merchant shipping as regards both individual countries and the world's total tonnage.

Merchant Shipping in 1919 and 1914.

The contents of the several tables, which are summarised below, will repay a careful study, but the one of most immediate interest and importance is that which sets forth the tonnage owned by different countries. The figures contained in the corresponding table which was issued with Lloyd's Register Book in July, 1914, showed that at that time there were about 45,404,000 tons gross of steamers and 3,686,000 tons net (approximately equal to 4,050,000 tons gross) of sailing vessels. The present figures are:—Steam tonnage, 47,897,000 tons, and sailing tonnage 3,022,000 tons. It will thus be seen that the tonnage of steamers has increased by nearly $2\frac{1}{2}$ million tons, while the sail tonnage has decreased by about 1,030,000 tons gross. No doubt the war has, to a certain extent, affected the amount of sailing tonnage, but in view of the fact that during the previous quinquennial period, 1909-1914, the decrease of sail tonnage was actually 380,000 tons more than the decrease recorded during the last five years, and taking into account the small proportion of the carrying capacity of the world's tonnage now represented by sailing vessels, it will be well to confine attention to the effects of the war on the steam tonnage of the world.

STEAM TONNAGE, JUNE 1919 AND JUNE 1914.

Country.	June, 1914. Tons gross.	June, 1919. Tons gross.	Difference between 1914 and 1919. Tonnage.	Percentage.
United Kingdom	18,892,000	16,345,000	—2,547,000	—13·5
British Dominions	1,632,000	1,863,000	+231,000	+14·1
America (United States): —				
Seagoing	2,027,000	9,773,000	+7,746,000	+382·1
Great Lakes	2,260,000	2,160,000	—100,000	—4·4
Austria-Hungary	1,052,000	713,000	—339,000	—32·2
Denmark	770,000	631,000	—139,000	—18·1
France	1,922,000	1,962,000	+40,000	+2·1
Germany	5,135,000	3,247,000	—1,888,000	—36·8
Greece	821,000	291,000	—530,000	—64·6
Holland	1,472,000	1,574,000	+102,000	+6·9
Italy	1,430,000	1,238,000	—192,000	—13·4
Japan	1,708,000	2,325,000	+617,000	+36·1
Norway	1,957,000	1,597,000	—360,000	—18·4
Spain	884,000	709,000	—175,000	—19·8
Sweden	1,015,000	917,000	—98,000	—9·7
Other Countries	2,427,000	2,522,000	+125,000	+5·2
Grand Total	45,404,000	47,897,000	+2,493,000	+5·5
Total Abroad	26,512,000	31,552,000	+5,040,000	+19·0

It will be seen that the sea-going tonnage of the United States has increased by about $7\frac{3}{4}$ million tons, equal to more than 382 per cent as compared with the 1914 totals. Japan has added 617,000 tons to her merchant tonnage, equal to over 36 per cent, and the British Dominions have added 231,000 tons, or over 14 per cent more. On the other hand, the countries where the greatest decrease has taken place are: the United Kingdom, showing a loss of more than $2\frac{1}{2}$ million tons, Greece 530,000 tons, Norway 360,000 tons, Italy 192,000 tons, Spain 175,000 tons, and Denmark 139,000 tons.

As stated in the Statistical Tables, enemy vessels which at the date of the Armistice had not been captured or requisitioned by other countries are included in the 1919 figures as German and ex-Austro-Hungarian. The tonnage of enemy vessels taken over by the Allies since the Armistice amounts to over $1\frac{3}{4}$ million tons. The figures given in the Statistical Tables for Germany are not, therefore, final figures. They indicate a loss of 1,888,000 tons at the date of the Armistice, as compared with 1914, but that figure will be considerably increased.

United Kingdom and United States.

One of the most striking results of the comparison of the 1919 and the 1914 figures is the relative position of the United Kingdom and the United States. In 1914, 41.6 per cent of the world's tonnage was owned in the United Kingdom, and 4.46 per cent was composed of sea-going tonnage of the United States; the present figures are: United Kingdom, 34.1 per cent; United States, 24.9 per cent, including 20.4 per cent of the sea-going tonnage. Although an exhaustive analysis of the material, size, and type of vessels included in these figures would be necessary to arrive at the exact relative position of the United Kingdom and the United States merchant fleets in the international trade, a few points may be mentioned which affect the question.

First, as regards material, there is no doubt that for several reasons wood tonnage can be largely excluded from consideration. The American sea-going tonnage would then be reduced to 8,426,000 as against 16,267,000 tons for the United Kingdom. As regards the size of vessels, it is a generally accepted fact that for ocean voyages large vessels are more efficient and economical than smaller vessels. Vessels of less than 2,000 tons are usually employed in the home trade or for short sea voyages in the foreign trade. For this purpose, the geographical position of the United Kingdom is more favourable than the position of the United States, as a large number of smaller vessels can be employed in the foreign trade of the United Kingdom than is possible in that of the United States.

SEA-GOING VESSELS OF 2,000 TONS GROSS AND UPWARDS.

	2,000 and under 4,000 tons.	4,000 and under 8,000 tons.	8,000 tons and above.
United Kingdom	1,042	1,485	263
United States	1,272	811	90

Foreign Mercantile Fleets.

After the United Kingdom and the United States —and excluding Germany—Norway, France, and Japan were the leading countries in 1914. The order, however, has now been reversed as regards Norway and Japan, the latter country now leading with 2,325,000 tons. France, notwithstanding her large losses during the war, has actually added 40,000 tons to the steam tonnage owned in 1914. Greece has suffered seriously owing to the war. In 1902 this country had 288,000 tons of steam tonnage, which in 1914 had grown to 821,000 tons. The present total, 291,000 tons is practically the same as was owned in that country 17 years ago. The loss of tonnage as compared with 1914 of the Scandinavian countries—Norway, Sweden and Denmark —amounts to about 600,000 tons, equal to 16 per cent of the total tonnage owned by these countries in 1914.

Norway has lost the largest amount, 360,000 tons, Denmark 139,000 tons, and Sweden 98,000 tons. Of the other principal neutral countries Spain has lost 175,000 tons, while the present figures for Holland show an increase of 102,000 tons. The combined net gain of France, Italy, and Japan amounts to 465,000 tons, and the losses incurred by the German and ex-Austro-Hungarian merchant navies at the time of the Armistice were already about $2\frac{1}{4}$ million tons.

Effect of the War.

A careful estimate has been made upon the following assumptions by Lloyd's Register of what the world tonnage would have been had there been no war:—

(1) It is reasonable to expect that the percentage of addition to the world's tonnage would have continued at the ratio (a decreasing one) recorded during the last 15 pre-war years, and that the percentage of the United Kingdom tonnage to the world's tonnage would show approximately the same ratio of decrease recorded during the most recent of these years.

(2) Countries in which there has been a large addition of tonnage during the previous quinquennial period might be expected to show a reduction in the ratio of increase, and, generally speaking, the larger the previous increase the larger would be such reduction.

(3) Allowances should be made in the special cases of countries where pre-war conditions pointed to the acquisition of tonnage, in the near future, at a higher ratio than what had actually been recorded during the previous period.

It would appear that the effect of the war on the principal countries, and on the world's tonnage has

been to cause the following difference between the actual figures for 1919 and the estimate made of present tonnage if no war had taken place:—

	Tons.
United Kingdom	—5,003,000
British Dominions	—199,000
Total	—5,202,000
United States (Sea)	+7,168,000
„ „ (Lakes)	—439,000
Total	+6,729,000
France	—536,000
Germany	—3,582,000
Holland	—384,000
Italy	—677,000
Japan	+20,000
Norway	—1,025,000
Other Countries	—2,816,000
Grand Total	—7,473,000
Total Abroad	—2,470,000

The Net Result.

Summarising these totals, it will be seen that the net result of the war on the world's merchant steam tonnage would appear to be as follows:—

	Tons.
Loss of British Tonnage	5,202,000
Loss of Foreign Tonnage (except U.S.A.).	9,000,000
	14,202,000
Net Gain to United States Tonnage	6,729,000
Net World's Loss	7,473,000

Comparing individual countries it is seen that by far the largest loss has been incurred by the United Kingdom, the tonnage of which is probably now over 5,000,000 tons less than it would have been but for the war. Excluding enemy countries, the greatest sufferers after the United Kingdom are Norway, to the extent of over 1,000,000 tons, Italy 677,000, and France 536,000 tons. The German loss is, already explained, less than the final figures will show when they are available. The only country which has increased her merchant fleet owing to the war is the United States, which, upon the above basis, has now over 7,000,000 tons of seagoing tonnage more than she would have had if war had not taken place. The increase in the case of Japan is but slightly higher than would have occurred under ordinary conditions.

The Loss in Efficiency.

The question of efficiency of the present steam tonnage has not been taken into account in the above figures. Quite apart from additions to the merchant fleets of the world, before the war, replacements of steam tonnage lost, broken up, etc., amounted each year to about 1½ per cent of the total tonnage owned, while during the war to replace the tonnage lost involved the construction of new tonnage equal to 33 per cent of the steam tonnage owned in 1914. Owing to these reasons there is no doubt that a large amount of tonnage is now in existence which, under ordinary conditions, would have been broken up and replaced by more modern and more economical vessels.

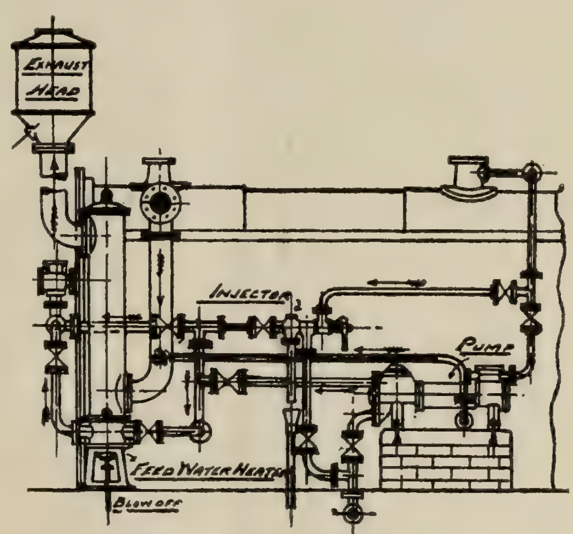
These remarks apply to the United Kingdom to a much greater extent than to other countries. During the three pre-war years 1911-1913, close on two million tons of steamers were sold to foreign countries, and, of course, replaced by better vessels, while during the three years 1916-1918 probably less than 100,000 tons of steamers were sold in this way. Moreover, it should be remembered that a large proportion of the tonnage built during the war is not equal in general efficiency to the tonnage which was built in the last few years before the war. Taking these considerations into account, it may reasonably be assumed that the world has lost through the war no less than 8½ million tons gross of shipping, which represents a deadweight carrying capacity of about 12½ million tons.

ENGINEERING LAY-OUT ARRANGEMENTS AND TENDER DRAWINGS.

By Douglas Wilson, A.M.I.Mech.E.

(*Continued from page 429.*)

Figs. 69 and 70 illustrate the general layout of a boiler feeding plant, this type of heater being used in conjunction with same. The delivery from pump may either pass through the heater or direct to boiler by means of the sluice valves shown. This is always to be recommended, as the heater can be overhauled, &c., any time without shutting down. It is also advisable to



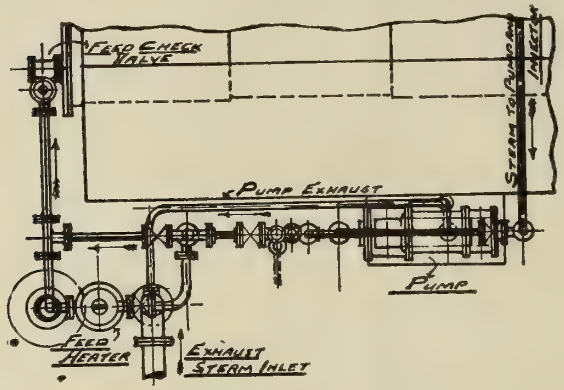
Engineering Lay-out.—Fig. 69.

provide for bye-passing the steam supply to heater. This entails three additional valves and two tees, as shown at Fig. 71. The valves here are of the wing type, all being simultaneously opened or closed by moving the lever connected to central valve. This makes a very handy arrangement. Gate valves are sometimes preferred to the wing type, being more steam-tight, but the time occupied in bye-passing the steam is, of course, considerably longer than the first method.

A live steam heater fixed close to the exhaust heater to be used as a stand-by, and coupled up to the delivery and steam piping, makes an ideal arrangement of boiler feed apparatus, as by suitably locating the valves in the pipe lines either heater can quickly be cut out or put into service. Referring to the exhaust steam heater

shown at Fig. 68, there are two water chambers; the heater entering at the top is distributed uniformly over the tube plate by impinging on the cup-shaped casting shown. The tubes are of brass, and the heaters are suitable for high boiler pressures.

This heater has a capacity of some 4,000 lbs. of

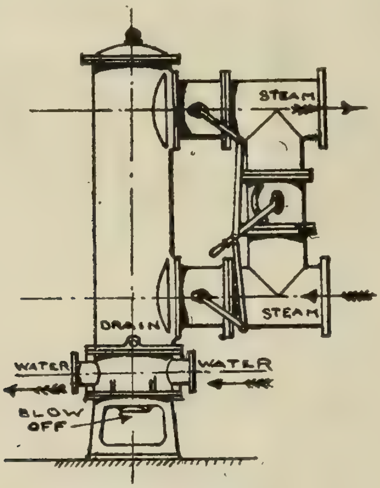


Engineering Lay-out — Fig. 70.

water per hour, the exhaust branches are 6 in. and the feed connections 2 in. bore.

For installations where economisers of the well-known Green type are used, it is not advisable to feed same with water at a lower temperature than 90 deg. F. If colder than this, the vaporous portion of the flue gases condense on the bottom boxes and tubes, causing corrosion. A simple method of preventing this is shown at Fig. 72. By taking a three-quarter inch pipe off the hot water feed from economiser to boiler, and connecting same to the pump suction, it enables a small quantity of hot water to be drawn into the cold feed at each stroke of the pump, thereby taking the chill off.

The size of an economiser is generally fixed by allowing for it to empty itself once every hour. For instance, a boiler evaporating 600 gallons per hour: this quantity

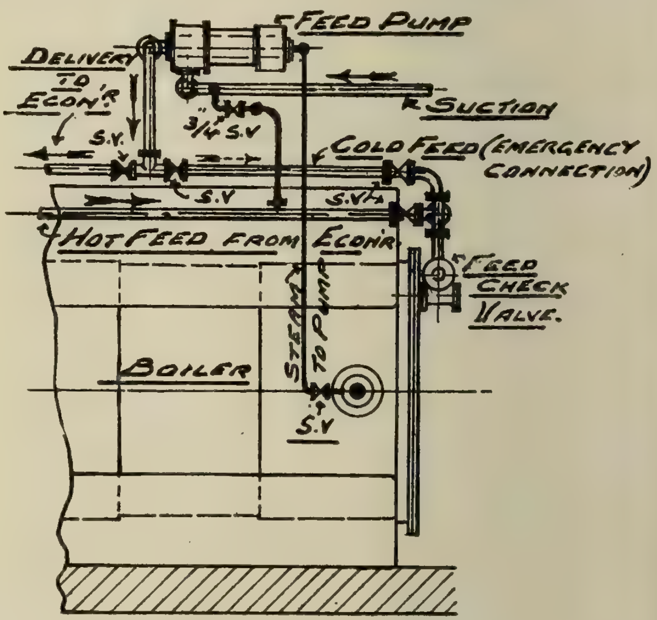


Engineering Lay-out.—Fig. 71.

divided by the capacity of one economiser tube, which is usually about $6\frac{1}{4}$ gallons, will give the number of tubes, namely, 96, this being the size of economiser suitable.

Feed-Water Measuring Apparatus.

For obtaining very accurately the evaporation of a boiler, or the steam consumption of an engine or turbine, there are several methods in practice, and may be briefly classed as: (1) The tank system; (2) the meter and venturi tube; (3) The V notch and Weir recorder systems. The tank system, as its name applies, measures the boiler feed directly through tanks of known capacity. The level of the water being checked for set heights every time it falls to the zero mark, thus by multiplying the area of tank by this height the amount of water can readily be obtained that has passed into the boiler. For measuring the steam consumption of engines or turbines the condensed steam as it is discharged from the air pumps is led into the tank or tanks, and the quantity measured in the same way, or often the tank full of water is weighed, this being the most positive way. Two tanks are generally adopted for this procedure with a suitable arrangement of valves for changing over the water into either tank. Some engineers insist on this method of checking their steam consumptions in preference to meter or recorder methods, especially when makers'



Engineering Lay-out.— Fig 72.

steam consumption guarantees are being verified. For all ordinary purposes, however, the tank system of checking feed and steam consumption is inconvenient, and takes up much room, so automatic recorders are much used, as they are very accurate and reliable, and occupy very little space in the engine room or boiler house, the errors due to variations in temperature, &c., not exceeding one per cent. The recorder can be fixed near the switch board or in any convenient position in the generating station. By installing automatic meters or recorders a continuous check can be made by the engineer of the total steam consumed on his turbines, &c., or the amount of water pumped into the boilers, a continuous record being automatically produced every day. This, of course, is not possible with the tank system of measuring.

(To be continued.)

Hull Motor Transport and Engineering Co. Ltd. (157,905).—Private company. Registered August 13th. Capital £1,000, £1 shares. As title. Directors: T. Simpkins and R. Markham. Registered office: 25, Dansom Lane, Hull.

Weights of Lengths of Rolled Steel Sections.

Beam 8 in. × 6 in. × 30·5 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 2 25·0	5 1 22·0	8 0 19·0	10 3 16·0	13 2 13·0	16 1 10·0	0 19 0 7·0	1 1 3 4·0	1 4 2 1·0	0
1	0 1 2·5	2 3 27·5	5 2 24·5	8 1 21·5	11 0 18·5	13 3 15·5	16 2 12·5	0 19 1 9·5	1 2 0 6·5	1 4 3 3·5	1
2	0 2 5·0	3 1 2·0	5 3 27·0	8 2 24·0	11 1 21·0	14 0 18·0	16 3 15·0	0 19 2 12·0	1 2 1 9·0	1 5 0 6·0	2
3	0 3 7·5	3 2 4·5	6 1 1·5	8 3 26·5	11 2 23·5	14 1 20·5	17 0 17·5	0 19 3 14·5	1 2 2 11·5	1 5 1 8·5	3
4	1 0 10·0	3 3 7·0	6 2 4·0	9 1 1·0	11 3 26·0	14 2 23·0	17 1 20·0	1 0 0 17·0	1 2 3 14·0	1 5 2 11·0	4
5	1 1 12·5	4 0 9·5	6 3 6·5	9 2 3·5	12 1 0·5	14 3 25·5	17 2 22·5	1 0 1 19·5	1 3 0 16·5	1 5 3 13·5	5
6	1 2 15·0	4 1 12·0	7 0 9·0	9 3 6·0	12 2 3·0	15 1 0·0	17 3 25·0	1 0 2 22·0	1 3 1 19·0	1 6 0 16·0	6
7	1 3 17·5	4 2 14·5	7 1 11·5	10 0 8·5	12 3 5·5	15 3 2·5	18 0 27·5	1 0 3 24·5	1 3 2 21·5	1 6 1 18·5	7
8	2 0 20·0	4 3 17·0	7 2 14·0	10 1 11·0	13 0 8·0	16 0 5·0	18 2 2·0	1 1 0 27·0	1 3 3 24·0	1 6 2 21·0	8
9	2 1 22·5	5 0 19·5	7 3 16·5	10 2 13·5	13 1 10·5	16 1 7·5	18 3 4·5	1 1 2 1·5	1 4 0 26·5	1 6 3 23·5	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	0 2·54	0 5·08	0 7·62	0 10·16	0 12·70	0 15·25	0 17·79	0 20·33	0 22·87	0 25·41	0 27·95	0 30·5	

Weights of Lengths of Rolled Steel Sections.

Beam 8 in. × 6 in. × 30·5 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	1 7 0 26	2 14 1 24	4 1 2 22	5 8 3 20	6 16 0 18	8 3 1 16	9 10 2 14	10 17 3 12	12 5 0 10	0
10	0 2 2 25	1 9 3 23	2 17 0 21	4 4 1 19	5 11 2 17	6 18 3 15	8 6 0 13	9 13 1 11	11 0 2 9	12 7 3 7	10
20	0 5 1 22	1 12 2 20	2 19 3 18	4 7 0 16	5 14 1 14	7 1 2 12	8 8 3 10	9 16 0 8	11 3 1 6	12 10 2 4	20
30	0 8 0 19	1 15 1 17	3 2 2 15	4 9 3 13	5 17 0 11	7 4 1 9	8 11 2 7	9 18 3 5	11 6 0 3	12 13 1 1	30
40	0 10 3 16	1 18 0 14	3 5 1 12	4 12 2 10	5 19 3 8	7 7 0 6	8 14 1 4	10 1 2 2	11 8 3 0	12 15 3 26	40
50	0 13 2 13	2 0 3 11	3 8 0 9	4 15 1 7	6 2 2 5	7 9 3 3	8 17 0 1	10 4 0 27	11 11 1 25	12 18 2 23	50
60	0 16 1 10	2 3 2 8	3 10 3 6	4 18 0 4	6 5 1 2	7 12 2 0	8 19 2 26	10 6 3 24	11 14 0 22	13 1 1 20	60
70	0 19 0 7	2 6 1 5	3 13 2 3	5 0 3 1	6 7 3 27	7 15 0 25	9 2 1 23	10 9 2 21	11 16 3 19	13 4 0 17	70
80	1 1 3 4	2 9 0 2	3 16 1 0	5 3 1 26	6 10 2 24	7 17 3 22	9 5 0 20	10 12 1 18	11 19 2 16	13 6 3 14	80
90	1 4 2 1	2 11 2 27	3 18 3 25	5 6 0 23	6 13 1 21	8 0 2 19	9 7 3 17	10 15 0 15	12 2 1 13	13 9 2 11	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	13 12 1 8	27 4 2 16	40 16 3 24	54 9 1 4	68 1 2 12	81 13 3 20	95 6 1 0	108 18 2 8	122 10 3 16	136 3 0 24	

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Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 8 in. × 6 in. × 29·5 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 2 15·0	5 1 2·0	7 3 17·0	10 2 4·0	13 0 19·0	15 3 6·0	0 18 1 21·0	1 1 0 8·0	1 3 2 23·0	0
1	0 1 1·5	2 3 16·5	5 2 3·5	8 0 18·5	10 3 5·5	13 1 20·5	16 0 7·5	0 18 2 22·5	1 1 1 9·5	1 3 3 24·5	1
2	0 2 3·0	3 0 18·0	5 3 5·0	8 1 20·0	11 0 7·0	13 2 22·0	16 1 9·0	0 18 3 24·0	1 1 2 11·0	1 4 0 26·0	2
3	0 3 4·5	3 1 19·5	6 0 6·5	8 2 21·5	11 1 8·5	13 3 23·5	16 2 10·5	0 19 0 25·5	1 1 3 12·5	1 4 1 27·5	3
4	1 0 6·0	3 2 21·0	6 1 8·0	8 3 23·0	11 2 10·0	14 0 25·0	16 3 12·0	0 19 1 27·0	1 2 0 14·0	1 4 3 1·0	4
5	1 1 7·5	3 3 22·5	6 2 9·5	9 0 24·5	11 3 11·5	14 1 26·5	17 0 13·5	0 19 3 0·5	1 2 1 15·5	1 5 0 2·5	5
6	1 2 9·0	4 0 24·0	6 3 11·0	9 1 26·0	12 0 13·0	14 3 0·0	17 1 15·0	1 0 0 2·0	1 2 2 17·0	1 5 1 4·0	6
7	1 3 10·5	4 1 25·5	7 0 12·5	9 2 27·5	12 1 14·5	15 0 1·5	17 2 16·5	1 0 1 3·5	1 2 3 18·5	1 5 2 5·5	7
8	2 0 12·0	4 2 27·0	7 1 14·0	10 0 1·0	12 2 16·0	15 1 3·0	17 3 18·0	1 0 2 5·0	1 3 0 20·0	1 5 3 7·0	8
9	2 1 13·5	5 0 0·5	7 2 15·5	10 1 2·5	12 3 17·5	15 2 4·5	18 0 19·5	1 0 3 6·5	1 3 1 21·5	1 6 0 8·5	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	Weight.
	2·45	4·91	7·37	9·83	12·29	14·75	17·21	19·67	22·13	24·59	27·04	29·5	

Weights of Lengths of Rolled Steel Sections.

Beam 8 in. × 6 in. × 29·5 lbs. per foot.

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-	0	100	200	300	400	500	600	700	800	900	Ft.
.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	1 6 1 10	2 12 2 20	3 19 0 2	5 5 1 12	6 11 2 22	7 18 0 4	9 4 1 14	10 10 2 24	11 17 0 6	0
10	0 2 2 15	1 8 3 25	2 15 1 7	4 1 2 17	5 7 3 27	6 14 1 9	8 0 2 19	9 7 0 1	10 13 1 11	11 19 2 21	10
20	0 5 1 2	1 11 2 12	2 17 3 22	4 4 1 4	5 10 2 14	6 16 3 24	8 3 1 6	9 9 2 16	10 15 3 25	12 2 1 8	20
30	0 7 3 17	1 14 0 27	3 0 2 9	4 6 3 19	5 13 1 1	6 19 2 11	8 5 3 21	9 12 1 3	10 18 2 13	12 4 3 23	30
40	0 10 2 4	1 16 3 14	3 3 0 24	4 9 2 6	5 15 3 16	7 2 0 26	8 8 2 8	9 14 3 18	11 1 1 0	12 7 2 10	40
50	0 13 0 19	1 19 2 1	3 5 3 11	4 12 0 21	5 18 2 3	7 4 3 13	8 11 0 23	9 17 2 5	11 3 3 15	12 10 0 25	50
60	0 15 3 6	2 2 0 16	3 8 1 26	4 14 3 8	6 1 0 8	7 7 2 0	8 13 3 10	10 0 0 20	11 6 2 2	12 12 3 12	60
70	0 18 1 21	2 4 3 3	3 11 0 13	4 17 1 23	6 3 3 5	7 10 0 15	8 16 1 25	10 2 3 7	11 9 0 17	12 15 1 27	70
80	1 1 0 8	2 7 1 18	3 13 3 0	5 0 0 10	6 6 1 20	7 12 3 2	8 19 0 12	10 5 1 22	11 11 3 4	12 18 0 14	80
90	1 3 2 23	2 10 0 5	3 16 1 15	5 2 2 25	6 9 0 7	7 15 1 17	9 1 2 27	10 8 0 9	11 14 1 19	13 0 3 1	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	13 3 1 16	26 6 3 4	39 10 0 20	52 13 2 8	65 16 3 24	79 0 1 12	92 3 3 0	105 7 0 16	118 10 2 4	131 13 3 20	

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Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

RECONSTRUCTION AND INDUSTRY.

By W. R. Needham.

We are not pre-eminently a provident people. In days of plenty we are prone to be spendthrift. It is just in prosperity, however, we show ourselves to least advantage. It takes adversity to bring us to our senses, and then, somehow or other, we find our feet. Though muddlers ever, we muddle least of all when we are really up against things. Indeed, if only hardship continue, as a nation, I fancy, we lead the van in adaptability and the invention mothered of necessity. This has at least been the experience of the past few years.

Unpreparedness.

How slack and unforeseeing we often were! We have just to hand a graphic and telling illustration of this, and Admiral Viscount Jellicoe's book has been a veritable eye-opener. Our salvation in the early days of the war lay in the fact, not that we were actually prepared to resist, but that our chief foe felt sure we must be. Really, this was all too typical of us. However, that was many months ago, and since then things have moved with a rapidity almost incredible. On Armistice Day we could look back upon a series of stupendous hammer-blow victories, the major part of them the direct result of British effort and British skill; we could regard with justifiable pride our pioneer position as an Air Force; and, despite our obvious shortcomings, we always had command of the seas. We have learned much who had direst need of lessons, numerous and hard. We are now well in our stride again. Pre-war-time peace and prosperity had seen us fat, indolent and fractious. All this is changed. Science has had her day. Our foeman appealed to the arbitrament of mechanical and scientific devilry; and, well for us, for humanity, and himself also, deficient and ill-prepared as we were, he has been beaten irrevocably.

Peace Problems.

Now peace, which not long ago we thought ages distant, is imminent, assured, practically accomplished. The old life, however, has passed away, never again to return. The black night is a memory, but it has ushered us, not to another yesterday, but to a new and strange to-day. It has been a night of ill-deeds through which we have won to daylight once more, but our morning is something entirely apart. We have entered upon a new era. Now is no mere repetition of then; last night has made that impossible.

Great and compelling as have been the problems of War, those of Peace are none the less vital and urgent. We have approved ourselves in regard to the one; it remains for us to carry forward a like thoroughness and humanity into our treatment of the other. We speak glibly enough about Reconstruction; and of cheap catch-words, it is probably our chief stock-in-trade. We regard it as the magic "open sesame" whereby the least democratic of us can gain entrance to the sacred precincts of democracy. But do we reconstruct? Are we preparing to do so? Have we any programme in mind, let alone drafted? The horses are restive in their stalls. Are we to close the stable-door after they have stampeded and escaped? All this is no matter for debate—at least, it should not be—it is of first importance, and must receive prompt but skilful handling. Among other questions, reconstruction as affecting industry takes a foremost place. The relations of capital and labour can never be as they were, nor should they be. John Smith, who has borne the Honourable Marmaduke Plantaganet to safety through the heaviest barrage, can never again be merely the factory hand in Plantaganet's cotton mill—not, at least, while the Honourable Marmaduke lives. Just as we trust that Woodrow Wilson's persistent idealism will find a practical outlet in the near future, and save the world, so we hope that the self-same spirit of co-operation, of mutual respect and goodwill, may characterise the relationships between employers of labour and workers. The conference chamber, not the lock-out, nor the strike ballot, should become the order of the day. Any Government which fails to realise its responsibility in this matter, to grasp its opportunity, stands convicted of crassest incompetence. True, it may fail in arbitrament, and be forgiven; but *laissez-faire* is the unpardonable sin. We want the bona-fide article, and not a hastily-convened and scratch assembly. A policy of absentee-landlordism will answer no longer. Our Arbitration Board must be a permanent institution, and truly representative of all classes and interests; its policy must be large-minded, progressive, constructive, as well as its functions judicial; and, above all, it must be unbiassed.

Welfare of Workers.

Lord Leverhulme has sketched in skeleton outline a scheme whereby he affirms increased leisure and adequate remuneration may be assured to the workers. The keystone of the structure is productivity—this, in his judgment, is the one essential; and the best means to secure increased production is the task to which he addresses himself.

Commerce and philanthropy seem, somehow, mutually antagonistic. It is by no means proved, however, that such is necessarily the case. Philanthropy as an end in itself is, of course, alien to the modern spirit of commerce, and in turn incurs its most unremitting hostility. As a means to an end, however, what would once have been stigmatised as grandmotherly interference has not only been tried, but has been found to succeed admirably. As a commercial proposition, that which increases efficiency pays well. Welfare work and the like has been pressed into the service of industry with altogether excellent results. These are signs of the times, and forecast trends and policies as yet only vague and visionary. Hygiene and psychology play no small part in the modern drama of work-a-day life, and the result is eminently satisfactory, even in terms of hard cash, and unmistakably so in its conservation and protection of human material. A shorter working day, paradoxical as it seems, is distinctly preferable on all counts to the long-drawn-out agony typical of former years He need be no profound student of economics or of humanity who discovers that habitual overwork is bad for master and man. The employer pays more for relatively less return, and that of inferior quality, while the workers gain financially at the expense of physical fitness. Who does

not know that overtime is always alarmingly expensive, and, when protracted of little, if any assistance? A short spell, when men are fresh and conscientious, is under exceptional circumstances worth the cost in the one case, and the emolument in the other. A systematic 80-hour week instead of a 53, or as now a 47-hour week, is a costly, a suicidal policy for all parties concerned. Of course, the worker, as a rule, applies the brake—whether consciously or unconsciously depends upon what make of man he is. Your opportunist, your time-server, does so of set purpose and with a knowing wink. Even the straight man who seeks to make good finds that nature will assert her authority, and automatically he obeys the law of physical self-preservation. Now this is true; deny it who can! Shorter hours, closely packed, intelligently used, adequately rewarded, are in every way to be preferred to long hours slacked through anyhow. A task undertaken with zest is usually as far advanced, and much better done, at the end of a six or seven-hour day, as the same work tackled in the dilettante manner we know so well during a nine or ten-hour day.

Production.

Greater and quicker production of needful commodities, by more workers, is what several men of insight and influence are striving to secure. Public-spirited, sympathetic students and employers, such as Lord Leverhulme realise the essential justice of Labour's claim to a fuller share of life's good things. More leisure time, together with such a standard of wages as shall prove adequate to provide reasonable opportunity for a sane and healthy recreation, and also afford utilitarian, educational, and cultural facilities—these things are the worker's due, if anything, under-due; certainly they are over-due. Such men as advocate these things are not mere dreamers, visionaries; they are clear-headed, astute men of thought and action, many of them great captains of industry. They hold that a long pull and a strong pull and a pull all together is what is needed. They propose and seek for a real co-partnership, an identification of interests, a broadening of responsibility, privilege and recompense. They see in all this Capital's hope and Labour's rights. Why should not each help the other? They believe it can be done. Some few progressives have tried the experiment in a small way and partially; and the results have confirmed them in their resolve to put the matter to a real and serious test.

If the workers themselves can be brought to see that their efforts count and are appreciated, the future is full of promise. Once let them feel that what they do is their own concern, that the "Dear Girl and Kiddies" at home benefit as really as does the firm they work for, or the public they serve, then labour becomes an enjoyment. When they take the greatest pride in the best work, are accorded praise where due, and praise is expressed in concrete form, then will be born a pride in and devotion to the company somewhat analogous to that loyalty the true cricketer has towards his own county, or the soldier to his regimental colours. Work enthusiastically done by enthusiastic workmen—production must increase. Anything which can bring practice more into line with this high ideal should at all costs be encouraged and fostered.

Take a hypothetical case: Due to prejudice and conservatism on the one hand, and till now necessary iron-bound rules on the other, a factory can produce only 100,000 articles per annum, which are sold at £1 each, and average wages run out at 8s. per article. Speeding up, however, production now increases to 150,000 per year, selling price, and average wage per unit, and number of employees remaining the same as before. If now net profit, after allowing for rent, price of material, wages, upkeep and establishment charges, depreciation of plant and buildings, etc., be 4s. per article, the annual total profit is increased from £20,000 to £30,000. As, however, there will be additional wear and tear on plant, we allocate £1,000 to cover this. Therefore, our corrected values are now £29,000 profit, as against £20,000 formerly. Translated into terms of dividend and weekly pay, this means that a 6 per cent return can comfortably swell to 8 per cent, and a £3 wage become £4 10s. Need anyone then be dissatisfied? This, though a purely suppositious example, illustrates how, in commodities answering a real demand, both capital and labour may mutually benefit. Here there is no inevitable opposition, but a real community of interest; and this is possible because both parties are out not to cheat the customer, but to meet and provide for his wants. If this highly desirable broadening of sympathy, enhancing of effort, and distribution of profits, is to be realised, however, it must be by the voluntary and eager extension of the co-operative spirit, and the consequent decline of selfishness and class suspicion and aloofness.

(To be continued.)

MOTORCYCLE DESIGN.

By D. S. Heather, B.Sc.

(Concluded from page 427.)

A leather link belt is not subject to distortion in the same manner as a rubber belt, but it has its own troubles when used with a variable pulley. The side of each link when new is a flat surface. This has to engage with the curved surface of the conical pulley flange. Consequently there is a first line contact only, as shown in Fig. 4. After a time the link faces wear into the shape of the curved surface of the pulley flange, and proper contact is obtained, the section on the plane AA being a parabola. Now, if the belt is dropped lower into the pulley, the curvature of the parabola varies, so that, as shown in Fig. 5, line contact only is again obtained. The belt will again wear into the new curve required, and if it is then returned to the top of the pulley, the state of affairs shown in Fig. 6 results. Thus, as in the case of the rubber belt, each change of gear ratio means momentary slipping and consequent belt wear. Any form of change speed gear which necessitates this is not satisfactory.

Complete chain transmission is much more satisfactory than any system incorporating belts, provided that proper arrangements are made for lubrication and adjustment of the chains, and correct alinement of the chain wheels is assured. Chain cases are not yet all that can be desired. They are apt to rattle and to leak oil, and once removed, are often very difficult to replace properly.

The arrangements made for chain adjustment are frequently crude in the extreme, and are often such as to make it impossible to ensure that the chain wheels are kept properly lined up. The chains must, in the future, be so housed and lubricated that it is possible to run them for the whole of their useful life without removing them from their wheels. No system is satisfactory in which it is necessary to remove them and bathe them in hot lubricant at frequent intervals.

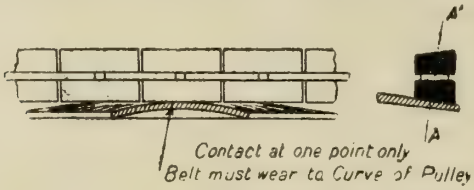


Fig. 4.—New Leather Link Belt at top of Pulley.

The merits of shaft drive do not appear to have been realised by English designers, but the author believes that its advantages are so numerous that it will eventually oust all other systems, as it has done on cars. The subject, however, is too wide to admit of full treatment here, and it is hoped that it may form the subject of a special paper later.

Miscellaneous.

Wheel hubs call for improvement, both in the exclusion of dirt and water from the bearings, and in the provision of more suitable means of lubrication. For heavy sidecar outfits the cup and cone bearing is not suitable for taking the heavy side thrusts imposed, in addition to the journal loads, and some form of thrust bearing should be employed. It may be mentioned here that adjustable ball-bearings of any type are undesirable, as an unskilled person may easily impose very heavy loads on them by incorrect adjustment, without the fact being noticeable until failure of the bearings occurs.

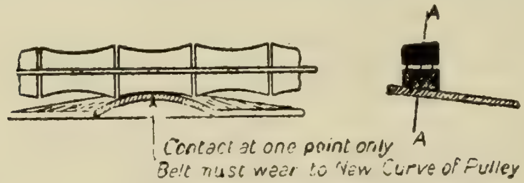


Fig. 5.—Leather Link Belt at bottom of Pulley.

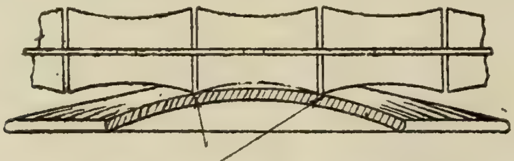


Fig. 6.—Worn Leather Link Belt returned to top of Pulley.

The self-contained unit type of bearing is far more satisfactory from every point of view.

The most satisfactory form of brake is the expanding shoe type, which can be completely enclosed and so protected from water, mud, or oil, and there are some very good examples on the road. Their general adoption is desirable for both front and rear wheels, in place of the belt rim type, except on the cheapest class of machines, where the question of cost will render the adoption of the latter necessary. In such cases the shoe should certainly be given a parallel motion, to ensure easy action and even wear. Brake rods should always be straight, for cranked rods are obviously bad and cause the brake gear to be very springy. Pin joints should be of reasonable proportions, and care should be taken to prevent rattling.

There are many other points in which improvement is desirable, which cannot be mentioned in the time available. The author trusts, however, that the foregoing remarks will give some idea of the general position of English motorcycle design at the present day, and thus assist in clearing the way for radical progress in the future, which will make the motorcycle a satisfactory, trouble-free, comfortable mount, comparable with the best of cars on every point except protection from the weather.

The design and scope of this paper, as explained in the author's opening remarks, have made it almost entirely critical in nature. That was inevitable under the circumstances. The paper has, however, been written to a certain extent in conjunction with a constructive paper which will be read this month by Mr. Eric Caudwell on "The Engine and Transmission of the Sidecar Machine."

(*Concluded.*)

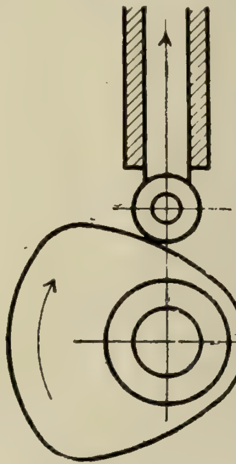
CAMS.

By W. E. Bennison, A.M.I.M.E.

(*Continued from page 265.*)

Applications of Cam Movement.

The following examples (Figs. 6 to 17) show how the angular motion of the cam is converted into other forms of motion. The examples chosen illustrate the ordinary types of cam motion which are to be met with in normal conditions.



Cams.—Fig. 6.

In every case the direction of rotation of the cam and the direction of motion of the follower are indicated by arrows. The examples are purely diagrammatic.

Fig. 6. Spiral cam, roller contact: Straight line motion away from axis, direction through axis.—In this case the follower is supposed to be a roller carried by

a bar which can slide in guides. By virtue of its rotation the cam surface presses against the roller and pushes the bar away from the axis of the cam. The line of motion of the centre of the roller passes through the axis. When the cam has rotated so far that the highest part (or part furthest away from the axis) is pressing

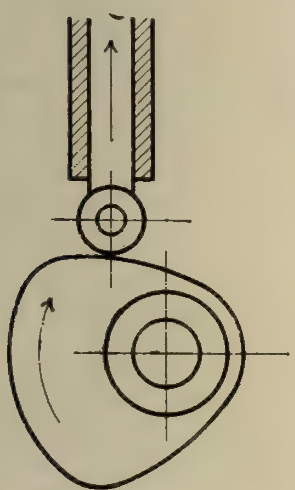


Fig. 7.

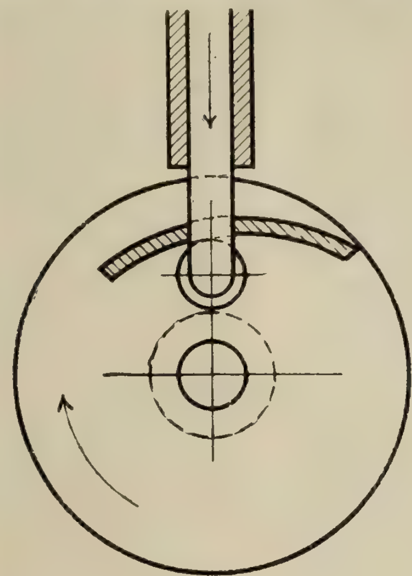


Fig. 8.

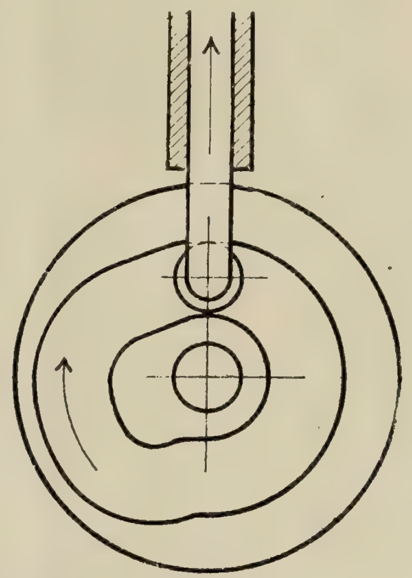


Fig. 9.

against the roller the bar has reached the limit of its outward movement. Further rotation of the cam will not move the bar any further; it will, in fact, cause a space to be left between the cam and the roller. It is obvious that the bar will have to be returned to its first position nearest to the axis by some means external to the cam.

Fig. 7. Conditions similar to Fig. 6, but direction of motion offset from axis.—In this example the roller and bar are shown in exactly the same position as in the previous one; the cam, too, is the same shape but occupies a different position in respect to the roller; the

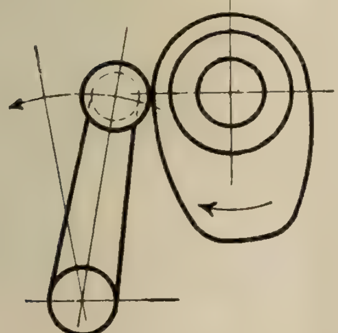


Fig. 10.

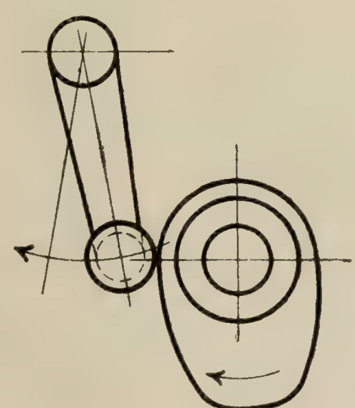


Fig. 11.

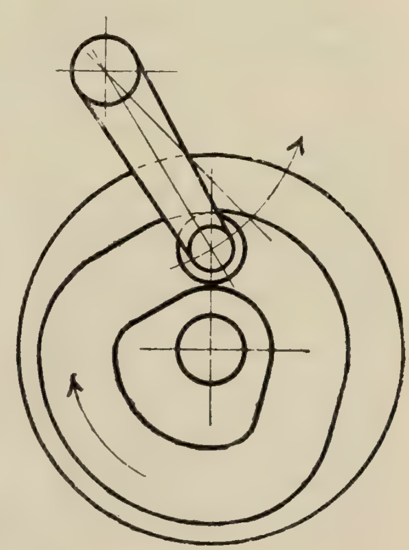


Fig. 12.

line of motion of the centre of the follower does not in this case pass through the axis but is some distance from it. The rotational position of the cam is quite different from the previous one. If the motion of the roller were plotted out it would be found that this cam will not lift the roller as high as, and will allow it to drop lower than, the roller in Fig. 6. It will be shown later on that the position of the axis of the cam in relation to the line of motion of the follower is an important factor in determining the shape of the cam.

Fig. 8. Spital cam, roller contact; straight line motion towards axis, direction through axis.—This case is the exact converse of Fig. 6. The cam surface is shown as a piece fixed on to a circular disc. The roller is between the axis and the cam surface and is being forced in the direction of the axis. The return to the extreme outward position will be by external means.

Fig. 9. Spiral cam, roller contact: Straight line motion both towards and away from axis, direction through axis.—This cam is a double-acting one. It is a combination of the cams shown in Fig. 6 and Fig. 8. During one part of a revolution the roller is moved away from the axis and during another part of a revolution is moved

towards the axis. One complete revolution of the cam will give one complete reciprocation of the sliding bar. The cam has two parts, or two cam surfaces : the interior surface, or that which is nearer to the axis of the cam, is the one which forces the bar outwards ; the exterior surface, or that which envelops the roller, is the one which forces the bar inwards. The space between these two surfaces forms a groove in which the roller runs.

Fig. 10. *Spiral cam, roller contact : Angular motion, away from axis.*—Here the actuated member is a lever fulcrumed, say, to the framework of a machine, and the roller is carried by the free end of the lever. The revolving cam surface pushes the roller away from the axis, and thus the angular motion of the cam is converted into angular motion of the lever. The path of the centre of the follower will be a circular arc. The lever is returned to its first position by external means.

Fig. 11. *Conditions similar to Fig.* 10 *but position of actuated member reversed.*—The position of the lever is exactly opposite to that in the previous example, other conditions being exactly similar. It will be observed that the direction of rotation of the lever in this example is clockwise and in the previous one anti-clockwise, the direction of rotation of the cam being clockwise in both cases ; as will be shown later, when designing cams this difference may affect the shape of the curve.

Fig. 12. *Spiral cam, roller contact : Angular motion in two directions.*—This cam is very similar in design to the one shown in Fig. 9, forcing the roller in both directions. The roller is carried by the free end of a lever, and the lever receives reciprocating angular motion. It cannot be said that the follower either moves towards or away from the axis : it simply swings across the cam owing to the great inclination of the lever. Here again this inclination will affect the cam form.

(*To be continued.*)

HEAT APPLIED TO ENGINEERING.

By Prof. W. W. Haldane Gee, B.Sc., M.Sc.Tech.

(*Continued from page 395.*)

Wire Gauges.

The choice of the diameters of the wires used in electric heating is limited by the sizes of the wires that are issued by wire manufacturers. These are generally restricted to the numbers of wire gauge tables. The result of "the battle of the gauges" has resulted in this country in the adoption of the Imperial or Board of Trade Standard Wire Gauge. Tables of wire gauges are of two classes (1) empirical, and (2) geometrical. The first class are those in which the steps between the sizes are arbitrary and do not follow any definite law. They have the advantage that all the numbers can be expressed by an exact number of mils. (that is, thousandths of an inch). The geometrical gauges, on the other hand, are formed by perfectly uniform decrements of size in geometrical progression. To express them, it may be desirable to tabulate the values to the tenth part of a mil. The report to the Council of the Society of Telegraph Engineers in 1879 advised that the old Birmingham Wire Gauge should be replaced by a new table based on that of Latimer Clark. The latter had proposed a geometrical gauge table in which the intervals are so arranged that each size is exactly 20 per cent less in weight and in electrical conductivity than the preceding size. Although this was shown to have many advantages in calculations, Latimer Clark's table was not adopted by the Board of Trade, who substituted the present empirical table. Meanwhile, in the United States, the table proposed by Messrs. Brown and Sharp in 1855 was coming into use and is now extensively employed by American Electrical Engineers. Wire imported to England follows this American gauge, so that it is necessary for students to understand how Brown and Sharp arrived at the sequence of sizes.

Commencing with the large size, 0000, which is 0·460 inches in diameter, and ending with the small size, 0·00314 of an inch, there will be (including 000, 00, and 0) 43 steps. From this data the ratio-factor k can be deduced from the expression :—

$$k = \sqrt[43]{\frac{460}{3 \cdot 14}} = 1 \cdot 123 = \sqrt[6]{2}$$

This ratio-factor is the key to the whole system. It gives the ratio of the diameter of successive wires. Thus to obtain No. 35 from No. 36, we have—

No. 36 = 5 mils.

No. 35 = $\sqrt[6]{2} \times 5 = 5 \cdot 61$ mils.

It also gives a connection between the areas of the wires. For example, a succession of diameters in the gauge table will have the relative sizes :—

$$1 : 2^{\frac{1}{6}} : 2^{\frac{1}{3}} : 2^{\frac{1}{2}},$$

and their corresponding areas will be

$$1 : 2^{\frac{1}{3}} : 2^{\frac{2}{3}} : 2,$$

showing that the fourth wire will have double the area of the first wire in the series of four.

American engineers use a special unit of area called the *circular mil.* This is the area of a circle of one mil. in diameter ; hence the area of a wire in circular mils. is obtained by squaring its diameter in mils. This is illustrated by the numbers below :—

No. (B. and S.)	Diameter in Mils.		Circular Mils.
1	289·3	..	83694·49
2	257·6	..	66357·76
3	229·4	..	52624·36
4	204·3	..	41738·49

The diameter only being expressed approximately, the above law for a double area for the fourth larger (No. 1 in the above table) is not exactly fulfilled. Reducing the above areas to three significant figures they become, 83,700, 66,400, 52,600, and 41,700.

The circular mil. must not be confused with the *square mil.*, which is the actual area of a circle of one mil. in character ; hence the area of a circle of d mils. in diameter is $\pi/4d^2$ square mils. This gives the rule : To convert circular mils. to square mils., multiply by 0·7854.

These American units are the source of some perplexity to English students, and care is required to avoid error when converting them to British and metric equivalents.

Practical Laws of Heating.

To obtain the real laws relating to electric heating it is essential to examine the values obtained in a series of experiments in which the heating has been produced under definite conditions. The wire heated may be straight or it may be a helical coil, in each case being freely exposed to the air. If it be embedded or supported by firebrick, &c., or bound on porcelain tubes and lagged,

then the heating laws will be very different to those of the former cases. The heating of a straight horizontal wire in the air has been investigated at the Lewis Institute, Chicago, and the results of an extensive series of experiments have been issued by the Driver-Harris Co., of Harrison, New Jersey. It will be of considerable interest to examine the values that have been tabulated for nichrome. This will be done after some general formulæ relating to wires have been discussed.

Electric Heating and Specific Resistance.

It follows from the fundamental laws of electric heating that the rate of production of heat will be the same for unit lengths of two wires of the same diameter when

$$C_1^2 \rho_1 = C_2^2 \rho_2$$

where C_1 and C_2 are the currents carried by wires of specific resistances ρ_1 and ρ_2 respectively. Hence

$$\frac{C_1}{C_2} = \sqrt{\frac{\rho_2}{\rho_1}}$$

or the currents are inversely as the square root of the specific resistances.

Example.—If a wire of nickel-chrome alloy carries 2 amperes, find what current will give the same rate of heating when passed through a copper wire of the same diameter as the alloy.

Answer.—

$$\frac{2}{C_2} = \sqrt{1/64} = \tfrac{1}{8}$$

or

$$C_2 = 16 \text{ amperes}$$

when the specific resistance of nichrome is 64 times that of copper.

The question arises: Will the temperature attained by the two materials be the same for the same rate of heating? The answer will be Yes, if it is allowable to assume that the rate of heat radiation per unit area is the same. This is frequently assumed to be the case, and the value $\sqrt{\rho_2/\rho_1}$ is called "the relative carrying capacity." The following table gives the value of this quantity for some metals and alloys:—

TABLE OF RELATIVE CARRYING CAPACITY.

Copper	1
Aluminium	0·74
Iron	0·40
Nickel	0·36
Manganin	0·19
Nichrome	0·13

Units of Specific Resistance.

In the tables issued by wire makers the value of the specific resistance is generally expressed in three ways:—

(A) *Microhms* per cm. length and cross section per square cm.

(B) *Ohms* per foot length and cross section per *square mil.*

(C) *Ohms* per foot length and cross section per *circular mil.*

If ρ is the value of A, to convert it to B we have:—

$$\frac{\rho}{10^6} \times \frac{12 \times 2{\cdot}54}{\left(\frac{2{\cdot}54}{1000}\right)^2} = \rho \times 4{\cdot}724$$

To convert to C the above result must be increased for the denominator will be decreased by $\pi/4$, a circular mil. being a larger unit than a square mil. This will bring the multiplier of ρ to 6·017.

The following examples of the use of these units are taken from the tables issued by Messrs. Henry Wiggin and Co. Ltd., of Birmingham. They will be found to be approximately in accord with the above conversion factors.

	A.	B.	C.
Chronic	93·5	441·7	562·4
Ferrozoid	84	397	505·3
Ferry	47·2	223	283·9
Tarnac	41	193·7	246·6
Cupro No. 1	26·5	125·2	159·4
Cupro No. 2	20·6	97·3	123·9
German Silver 30 per cent	40·2	189·9	241·8
Zodiac	36	170	216·5
Pure Nickel	9·6	45·3	57·7

Variation of Specific Resistance with Temperature.

Unless the temperature coefficient is very low there is a considerable increase of electrical resistance as the wire gets hotter. This necessitates an increase of voltage to maintain the current; especially is this the case with iron and nickel—which have especially high temperature coefficients. Iron wire being cheap, it is frequently used as a resistor for rheostats and low temperature furnaces, so that it is desirable to have some knowledge of its rate of change up to a low red heat. This is expressed by the following formula:—

$$\rho_t = \rho_o (1 + \alpha t + \beta t^2)$$

where for degrees centigrade:—

$$\alpha = 0{\cdot}00452$$
$$\beta = 0{\cdot}00000583$$

Example.—Find the increase of an ohm of iron wire at 0 deg. Cen. when heated to 500 deg. Cen.

Answer.—$\rho_{500} = 1 + (0{\cdot}00452 \times 500) + (0{\cdot}00000583 \times 500^2) = 3{\cdot}72$ ohms.

Hence the increase will be 2·72 ohms.

(To be continued.)

MORE THAN 2,000,000 H.P. ELECTRIC ENERGY GENERATED IN CANADA.*

THAT there is upwards of 2,000,000 H.P. of electrical energy generated in Canada is demonstrated in the report on Electric Generation and Distribution in Canada about to be issued by the Commission of Conservation. The investigation into this subject has extended over a number of years and has been a most comprehensive one. Two of the principal points to bring out are the large part water-power plays in the production of electricity and the fact that over three times as much power is produced by privately-owned plants as by those publicly owned.

Water Power Predominates.

There are, according to the report, 565 electric generating plants in Canada, with an aggregate capacity of 2,107,743 H.P. These supply 752 distributing systems, which serve 973 localities.

* *Canadian Machinery.*

Classified according to the prime movers used, these plants are divided as follows:—270 hydro-electric, aggregating 1,806,618 H.P.; 201 steam plants, aggregating 288,202 H.P.; 49 gas plants (nearly all producer-gas), aggregating 8,157 H.P.; 45 oil or gasolene engine plants, aggregating 4,766 H.P.

These figures give a very fair idea of the power situation, and show the unquestionable predominance of water-power. In the Maritime Provinces, steam and water-power predominate, with the former in the ascendancy. In Quebec, Ontario, and eastern Manitoba water-power is the dominating source of power, every large centre and most of the smaller ones being supplied by electricity produced from water-power. In the Middle West, large plants are steam-operated, while the smaller ones use internal-combustion engines. In British Columbia and Western Alberta, water-power again predominates, but the generous coal supply in certain districts also permits considerable steam operation.

In the large hydro-electric installations, the report says, the type of plant is of the most up-to-date and substantial construction, but the same, unfortunately, cannot be said of many of the small plants, particularly the older ones. Old, leaky dams and inefficient types of water-wheels in bad repair are often the real causes of shut-downs attributed to lack of water. Likewise in the large steam plants, efficiency is shown, but this is not generally true of the smaller ones. For the prairie provinces, where fuel and the costs of generation are high in price, the report suggests that it would be more economical to generate electric power in large central steam plants and distribute it over transmission lines.

More Privately-owned Plants.

The report shows that there are 207 municipal or publicly-owned plants of 452,508 H.P. capacity and 358 plants privately owned with a capacity of 1,655,235 H.P. The Niagara System of the Ontario Hydro-Electric Power Commission is the largest under public ownership. It has a load of over 201,000 H.P., supplies 120 municipal distributing systems, and serves an area of 210 miles long by 85 wide. The largest privately-owned system is the Shawinigan in Quebec, with a load of 205,000 H.P., supplying 76 distribution systems and serving a triangular area with a base of 140 miles and a height of 75 miles.

The largest hydro-electric development is 488,800 H.P. in the three large power plants at Niagara. The large installations are not all confined to this site, however, as there are, in addition, five plants of over 100,000 H.P. and 36 plants of over 10,000 H.P. capacity. The large single plant is the Ontario Power Co., now operated by the Ontario Hydro-Electric Power Commission at Niagara, with a total capacity of 211,300 H.P. The largest single unit thus far installed in Canada is 20,000 H.P., at Grandmere, Que., though the Ontario Hydro-Electric Chippawa plant will contain units of 50,000 H.P., while future plans contemplate the use of 100,000 H.P. units.

The average head of water utilised is not exceedingly high, but many large hydro-electric plants operate under fairly high heads, such as 140 to 180 ft. at Niagara, 145 ft. at Shawinigan, 83 ft. at Grandmere, and 400 ft. at the Coquitlam-Buntzen plants near Vancouver. The highest head in Eastern Canada is 540 ft. at the 8,000 H.P. plant at Eugenia Falls, Ont., while, in the West, a head of 1,820 ft. is utilised at Britannia Beach, B.C., where the development also provides a total head of 3,530 ft. in two steps of 7,450 ft. and 2,080 ft. for the direct operation of other machinery. On the other hand, one of the largest plants recently installed at Cedars, Que., operates under a head of 30 ft.

The 26,667-H.P. plant at Hamilton, Ont., is the largest steam-power plant in Canada, and is used as an auxiliary. The 14,234-H.P. plant at Edmonton, Alta., is the largest steam plant operated continuously.

Storage Reservoirs Increasing.

No less than 59 plants report the successful operation of storage facilities to provide for increased flow at low-water periods. Among Government undertakings of this nature may be mentioned the three large reservoirs at lakes Timiskaming, Kipawa and Quinze to regulate the flow of the Ottawa river; La Loutre reservoir on the St. Maurice river; lake St. Francis dam for the St. Francis river, Que.; the extensive system of small conservation reservoirs on the Trent river, Ont.; lake Minnewanka, on the upper waters of Bow river, Alta., and the reservoirs on Jordan river and Goldstream, near Vancouver, B.C. Most satisfactory results have been obtained from

ELECTRIC PLANTS IN CANADA, SHOWING CAPACITY, OWNERSHIP AND PRIME MOVERS.

Province.	Plants.		Ownership.				Kind of Prime Mover.					
			Private.		Public.		Hydraulic.		Steam.		Int. Combustion.	
	No.	Capacity H.P.	No. of Plants	Total Capacity H.P.	No. of Plants	Total Capacity H.P.	No. of Plants	Total Capacity H.P.	No. of Plants	Total Capacity H.P.	No. of Plants	Total Capacity H.P.
Nova Scotia	38	27,177	24	23,064	14	4,113	12	3,474	23	23,478	3	225
Prince Edward Island	9	1,314	9	..	..	..	5	207	2	475	2	632
New Brunswick	23	18,607	16	16,212	7	2,395	8	7,463	12	10,014	3	1,130
Quebec	119	625,061	99	604,903	20	20,158	92	585,911	20	38,791	7	359
Ontario	173	899,856	105	609,658	68	290,198	113	831,004	50	66,519	10	2,333
Manitoba	23	103,015	8	53,706	15	49,309	4	78,550	13	23,841	6	624
Saskatchewan	62	30,593	26	2,682	36	27,911	..	..	15	26,585	47	4,008
Alberta	52	85,117	27	43,235	25	41,882	4	31,980	42	51,805	6	1,332
British Columbia	63	306,776	41	290,234	22	16,542	1	10,000	2	227	..	2,280
Yukon	3	10,227	3	10,227	..	..	31	258,029	22	46,467	10	..
Canada	565	2,107,743	358	1,655,235	207	452,508	270	1,806,618	201	288,202	94	12,923

storage undertakings, the capacity of plants being frequently doubled or more than doubled.

The utilisation of the large peat areas in the north part of Jutland is receiving much attention. The area is said to be as much as 28,000 acres, which, according to "Ingenioren," could be completely drained by gravitation, and the total contents might be equivalent to 23 million tons of coal. It is suggested that the peat could be utilised (1) as air-dried briquettes used for heating the boilers of adjacent electrical supply works; (2) as machine-made briquettes sold for general consumption as far away as the cost of transport will allow; (3) as peat litter to be sold to neighbouring farmers; (4) the lower parts of the bogs should be reclaimed and used for agriculture. The heating value of the peat is assumed to be half that of coal. The works required should be executed by private enterprise, aided by the State, and the cost of reclamation would amount to £50,000. The first 9,000 acres could be dealt with in 20 years, and the rest of the land occupied in course of time as the peat is cleared away.

New Companies Registered.

Bullivant's Engineering and Contracting Co. Ltd. (157,893).—Private company. Registered August 13th. Capital £5,000, £1 shares. To carry on the business of general engineers and contractors, manufacturers of or dealers in wire rope tramways, mining and hauling plant and telegraph cables, aerial ropeways and apparatus, and any substances or goods in the manufacture of which wires or metallic ropes can be used, etc. The first directors are F. A. Bullivant, P. J. Bullivant, B. S. Bullivant, and A. W. Bullivant (all permanent). No qualification required. No other directors may be appointed without the consent of Bullivant and Co. Ltd., who have also power of veto in certain other matters (sale of forfeited shares and increase of capital). Registered office: 72, Mark Lane, E.C.

Automobile Engineering Co. Ltd. (157,865).—Private company. Registered August 14th. Capital £10,000, £1 shares. To take over the business carried on at St. George's Garage, Bessborough Place, Pimlico, S.W.1, as the "Automobile Engineering Company." Agreement with J. J. Vredenburg. Directors to be appointed by the subscribers. Registered office: 24, Maddox Street, W.1.

British American Industries Ltd. (157,865).—Private company. Registered August 12th. Capital £10,000, £1 shares. To carry on the business of vendors, dealers, factors and manufacturers of motor vehicles, aircraft, electrical apparatus, and other component parts, etc. Agreement with Morris, Russell and Co. Ltd., Morris, Russell and Co. (Incorporated), H. C. Adams, F. J. Gordon, A. S. F. Morris and W. S. Wilkins. Directors: A. S. F. Morris (Chairman), F. J. Gordon, H. C. Adam and W. S. Wilkins. Qualification £250. Registered office: 75, Curtain Road, E.C.

Constant Speed Spring Co. Ltd. (157,929).—Private company. Registered August 14th. Capital £1,500, £1 shares. To carry on the business of founders, wire drawers, mechanical, wireless, electrical and mining engineers, manufacturers of and dealers in automobiles, cycles and carriages, etc., and to enter into an agreement with H. B. Collins and T. F. Redington. The first directors are M. M. Gillespie, H. T. Harrison, and H. B. Collins. The British Electric Equipment Co. Ltd., may, while holding any shares, appoint three directors, of whom M. M. Gillespie shall be first. Registered office: Amberley House, Norfolk Street, W.C.

Ashfeild Motor Transport and Engineering Co. Ltd. (157,889).—Private company. Registered August 16th. Capital £5,000, £1 shares. As title. The subscribers are to appoint the first directors. Secretary, W. H. Wightman. Registered office: 37, Station Street, East Kirkby, Notts.

Greenside Foundry Co. Ltd. (157,987).—Private company. Registered August 16th, by Jordan and Sons Ltd., 116-17, Chancery Lane, W.C. Capital £2,000, £1 shares. To take over the business of an ironfounder and manufacturer of stoves and grates carried on as the "Greenside Foundry Co." at the Greenside Foundry, Chapeltown, Yorks. Directors: H. R. Hodkin, E. Hodkin, W. Hodkin, and A. Hodkin. Qualification £100. Registered office: Greenside Foundry, Smith Street, Chapeltown, near Sheffield.

Rapid Rims Ltd. (157,856).—Registered August 11th. Capital £150,000, in 130,000 preference ordinary shares of £1 and 400,000 ordinary shares of 1s. each. To acquire an invention for improvements in detachable wheel rims for automobile and other vehicles, etc. Agreement with the Patents Acquisition Syndicate Ltd., Carmen de Fleury and E. F. Carty. First directors: J. E. D. Ryder, J. E. Platt, H. J. Hardy, E. F. Sterrwatkins and A. Jordan. Office: 7, Pall Mall, S.W.1.

Red Bar Manufacturing Co. Ltd. (157,972).—Private company. Registered August 15th. Capital £1,500, £1 shares. Engineers, tool makers, etc. Agreement with P. Redding and A. Barker (all permanent). Secretary: H. Podesta, 60, Torrington Square, W.C.1. Registered office: 87a, High Street, Harlesden.

A. Leonard and Co. Ltd. (157,862).—Private company. Registered August 12th. Capital £25,000, £1 shares. To take over the business of mechanical and general engineers and manufacturers carried on at Hampton Road, Croydon, as "A Leonard and Co." Directors: A. Leonard Pailthorpe and F. G. Pailthorpe. A. Leonard Pailthorpe may retain office while holding £1,000 shares. Registered office: Hampton Road, Croydon, Surrey.

Reviews.

BOILER STEEL AND EXPERIENCE WITH HIGH-PRESSURE BOILERS. Manchester: The Vulcan Boiler and General Insurance Co. Ltd., 67, King Street. 2s. 6d. net.

This work sets out to consider the characteristics of boiler steel and the proper treatment of this material in the construction and repair of boilers. We therefore get chapters dealing with the manufacture and tests of the material, its strength and properties. The later chapters will, however, be of most interest to steam users, particularly the last two, dealing with the high-pressure steam boiler in use, and the book is most interesting and instructive.

MACHINE AND FITTING SHOP PRACTICE (Vol. II.). By George W. Burley, Wh. Ex. London: Scott, Greenwood and Son, 8, Broadway, Ludgate, E.C. 6s. net.

The second volume of "Machine and Fitting Shop Practice" deals with Planing, Shaping and Slotting, Drilling, Boring and Reaming; Milling and Gear-wheel Cutting; Lathe Work; Grinding and Lapping; Screw-thread Cutting; and Interchangeable System of Manufacture. The book is intended for engineering works, apprentices, and engineering college and technical school students. It is eminently practical, and much attention has been paid to the principles and methods of working, processes, operations, tools and instruments. The book is clearly illustrated.

RECONSTRUCTION AND FOREIGN TRADE. By Ernest T. Williams, M.I.E.E. London: James Selwyn and Co. Ltd., 20, Essex Street, Strand, W.C.2. 2s. net.

This book expounds another method of improving our trading status. It does not deal with politics, but approaches the question from another side, and advocates the formation of what is termed a Federation of Commerce. "It is not a Ministry, a Board, a Corporation, an Association, or a Department; but a Federation to co-ordinate all sections and interests in the British Empire dealing with foreign and inter-Empire trade." It means apparently scrapping some of our old institutions, and aims at doing work that the Board of Trade have recently commenced to do so well.

Trade Items, Notes, &c.

German Ore Supplies.—We learn from various sources that the German iron foundries have now concluded contracts with the Swedish mines for the supply of ores, and, in this way, the steady supply of the necessary raw material has been secured for some considerable time to come. According, also, to the *Rhenish-Westphalian Times*, during the past week or two enormous quantities of Lorraine and Luxemburg oolitic iron ore have again been sent into the unoccupied districts of Germany; the price paid was from fcs. 70 to fcs. 80 per ton.

New Waterways in Poland.—A Bill is now before the Polish Committee of Public Works, by the terms of which the State will have to undertake and find funds for the improvement or construction of the following waterways :—The Vistula and its affluents, but more especially the San, the Bug, and the Narew; the Warta; a navigable canal from the coal basin of Upper Silesia and Dombrowa, via Czestochowa, near Lodz, up to the Vistula close to Warsaw, with a branch to the Vistula near Plock; a navigable canal connecting the Bug, near Zegrze, with the Vistula in the vicinity of Warsaw; and a junction canal between the Dniester and the Bug via Lwow. The Diet has given the Minister of Public Works, for the year 1919, a credit of 50 million marks in order to place the decree in execution.

National Health Week.—We understand that it has been decided to hold the first post-war National Health Week in May, 1920. Previous to the war, the celebrations in connection with this week, both in the Metropolis and in the various local centres throughout the kingdom, served to focus public opinion and sentiment on those aspects of personal and public hygiene which are more directly the province of the man in the street and the woman in the home than of the medical and sanitary authorities. We think it is not making too great a claim to state that the pioneer work done by the Health Week Committee was one of many like factors in establishing the need for the newly-formed Ministry of Health.

National Physical Laboratory.—The Lord President of the Council has appointed Professor Joseph Ernest Petavel, D.Sc., F.R.S., M.I.Mech.E., etc., to be Director of the National Physical Laboratory in succession to Sir Richard Glazebrook, C.B., F.R.S., who retires on reaching the age limit on September 18th. Professor Petavel is Professor of Engineering and Director of the Whitworth Laboratory in the University of Manchester. He is a member of the Advisory Committee for Aeronautics of the Air Ministry. He was educated at University College, London, and undertook scientific research at the Royal Institution and at the Davy-Faraday Laboratory until 1898. He was elected John Harling Fellow of the Owens College, Manchester, in 1900, and was Scientific Manager of the Low Temperature Exhibit of the British Royal Commission for the St. Louis Exhibition, 1904.

Utilisation of the Rhone Water Power.—A meeting has recently been held at Paris of representatives from French industrial and shipping circles, in order to decide as to an increase in shipping on the Rhone and a wider use of the hydraulic power afforded by that river. According to the preliminary investigations and reports of a committee appointed for the purpose, it is estimated that a sum of one and a half million francs would be required to carry out the work; this amount is to be raised by the participation of engineers, towns, villages, cities, chambers of commerce, and, if necessary, of the Government also. As, if the plan is carried out, it would soon be possible to supply Paris with 200,000 kilowatts electric energy, both Paris and the Seine Department will be asked to finance the enterprise.

Imperial Institute of Patentees.—A new association is being formed by patent owners and manufacturers with the object of protecting their interests. The association will probably be known as the Imperial Institute of Patentees (Incorporated), a licence from the Board of Trade having been applied for. A preliminary meeting took place in the Pillar Hall, Cannon Street, Hotel, on Thursday, the 10th inst. Mr. Godfrey Cheeseman, the general secretary of the National Union of Manufacturers (Incorporated), has been appointed to act as organising secretary to the new association. Temporary offices have been secured at 6, Holborn Viaduct, London, E.C.4, and all interested in patents should apply for information. The chair was occupied by Sir Joseph Lawrence, Bart., of Messrs. Linotype and Machinery Ltd.

Smokeless Fuel.—The serious position consequent upon the developments in the coal industry has for some time past been engaging the attention of scientists and engineers and of many others concerned with the industrial position of the country. The effects of the reduction of the coal output on the industries of the country generally are apparent. The result is that new substitutes for fuel are being daily investigated. Much is expected from the use of oil as a motive power in industry, but it will be some time before it is likely to help the domestic situation. A new enterprise, which will be known as the Reliance Fuel Company Limited, is about to be organised under serious auspices. The company proposes to carry on the manufacture of briquettes and smokeless fuel under a special trade process in conjunction with machinery which has been specially designed for the purpose. An important aspect of the enterprise is that it will be able to utilise extensively anthracite coal, which at present can be employed in connection with comparatively few industries. Mr. Howard Houlder (director of Howard, Houlder, and Partners Ltd.) and Mr. William Holford Dixon (director of Harris and Dixon Ltd.) will be associated with the new enterprise.

Extension of Osaka Waterworks (Japan).—An extension scheme for the supply of water to Osaka provides for a population of over 3,000,000. In their present condition the Osaka Waterworks have a maximum capacity of supply equivalent to the requirements of a population of 1,950,000, and it is anticipated that in 1922 the demand will reach this limit. The new scheme aims at a capacity of supply amounting to an average of 3.2 cubic feet per day at 3,100,000 persons. This average figure includes the demands of Osaka's many factories and workshops. The estimated cost of the extension work is put at yen 9,700,000 (approximately £1,080,000). Operations are to be commenced in October and completed by March, 1923. Before the work can be taken in hand, the approval of the Ministry of the Interior will have to be obtained, and the plans have already been submitted for consideration. Of the machinery, etc., required in this connection the following items may be of interest to British manufacturers: Three pumps for use at the intake, capable of raising 1,776 cubic feet of water per minute to a height of 28 ft. The pumps are to be vertical, directly connected with motors. Twelve Pumps for transmitting water from reservoirs, capable of raising 600 cubic feet of water per minute to a height of 160 ft. The pumps are to be vertical pumps, turbine style, directly connected with motors. Three 1,500-kilowatt dynamos, directly connected with steam turbines. Four 1,000-kilowatt transformers for receiving 3,000 kilowatt current. A list of United Kingdom firms (with branches at Osaka) manufacturing the above machinery can be obtained on application to the Department of Overseas Trade.—*Board of Trade Journal.*

James Watt Centenary.—The centenary of the famous inventor, James Watt, born 1736, died 1819, will be commemorated on September 16th, 17th, and 18th, at Birmingham, where he spent the best part of his life, after laying in Scotland the foundation of his greatest achievement. The proceedings will open with a service in Handsworth Parish Church, his burial place, after which a visit will be paid to Heathfield Hall, his home from 1790 till his death. On the second day there will be lectures dealing with the application of science to industry, and visitors will be shown two Watt engines in the vicinity of the city, one at Ocker Hall and the other at Bordesley. The arrangements for the same day also include a centenary dinner. On the third day more Watt engines will be on exhibition, and the University of Birmingham confers honorary degrees upon distinguished engineers and scientists. Many relics of Watt, of his partner, Boulton, and of their contemporary, Murdoch, who made the first gas-holder, will be on view each day. Some 20 universities and numerous societies and institutions are represented on the general committee, of which the Lord Mayor of Birmingham is president, and Mr. William Mills, M.I.Mech.E., chairman. The official representative of the Royal Society of Arts is Sir Dugald Clerk, K.B.E., D.Sc., F.R.S. As a permanent international memorial of Watt, it is proposed (1) to endow a professorship of engineering to be known as the James Watt Chair at the University of Birmingham for "the promotion of research in the fundamental principles underlying the production of power and the study of the conservation of natural sources of energy"; (2) to erect a James Watt Memorial Building, to serve as a museum for collecting together examples of the work of Watt, Boulton, and Murdoch, and as a meeting place for scientific and technical societies; and (3) to publish a memorial volume.

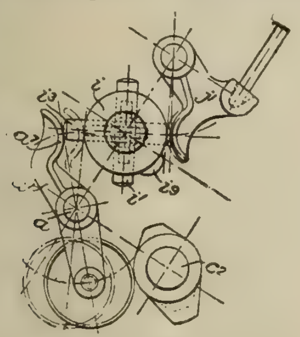
Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

INTERNAL-COMBUSTION ENGINES.

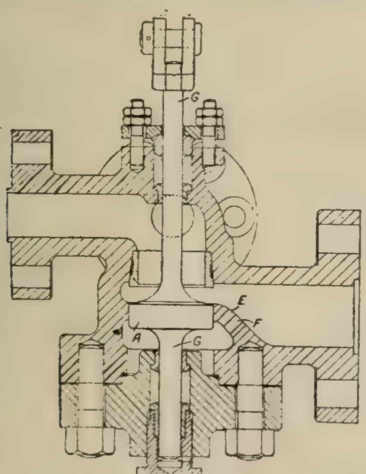
120,817.—G. M. BLACKSTONE, F. CARTER, and E. CARTER, Rutland Engineering Works, Stamford, Lincolnshire.—Dec. 22nd, 1917.—In a starting or reversing valve-gear, a series of levers is actuated from a second cam-actuated series through distance-pieces, which can be moved into or out of engagement with the levers. In the form shown, the valve levers *j*1 are actuated from the cam-actuated levers *a*1 through two sets of distance-pieces *i*1, *i*3



carried by a rock-shaft *i*. The distance-pieces *i*1, *i*3 serve respectively to actuate the valves for starting and working. The cam-shaft *c*2 carries separate forward and reverse cams, and the levers *a*1 are carried by a shaft *a* longitudinally movable for bringing the levers into engagement with the forward and reverse cams: the ends *a*7 of the levers *a*1 are broad enough to engage the distance-pieces in either position of the shaft *a*. A cam *i*9 on the rock-shaft *i* holds the exhaust valve open when the shaft is in neutral position with the distance-pieces out of action. A handle for actuating the shaft *i* is connected to a lever which opens a valve supplying compressed air for starting when the shaft *i* is in starting position.

VALVES.

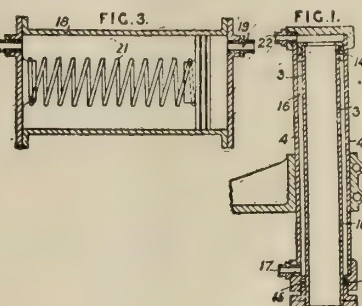
120,819.—J. CROW, 77, Merrylee Road, Newlands, Glasgow.—Dec. 31st, 1917.—A lift valve, particularly applicable for use with hydraulic machines, has the casing formed with a housing E into



which the valve member A is moved when the valve is opened. The valve spindle G passes through both sides of the valve chamber, and the housing has an aperture F to balance the valve and thus facilitate actuation.

LIFTING-JACKS.

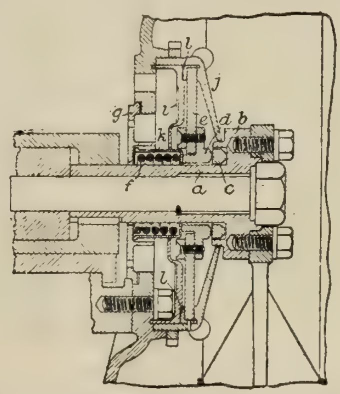
120,988.—E. GRAHAM, Dunottar, King's Road, Knock, and G. BOWMAN, Ballygomartin Road, both in Belfast.—Dec. 4th, 1917.—The ram of a fluid-pressure-actuated jack for motor vehicles is returned by fluid pressure or by suction. The space 16, Fig. 1, between the outer wall of the ram 3 and the inner wall of the jack casing 4 is closed by glands 14, 15, and fluid under pressure is admitted to this space by the port 17. The ram is actuated by fluid admitted through the port 22, and during its outward movement, the fluid in the space 16 is forced through the port 19 into the cylinder 18, where it compresses the spring 21, and is retained until it is desired to return the ram. The cylinder 18 may be dispensed with, and fluid under pressure from a pump may be used to return the ram. In a modification, the port 17 is dispensed with, and the ram is returned by connecting the port 22 to a vacuum chamber. The pressure within the jack may



be maintained by a valve on the supply pipe when the pressure supply is cut off. The necessity for accurately boring the jack casing 4 is avoided by arranging the packing-gland 15 so that it bears on the outer wall of the ram below the end of the casing. Specification 115,724 is referred to.

STUFFING-BOX SUBSTITUTES.

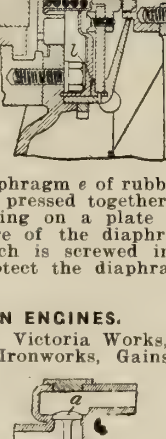
120,837.—W. E. SAVERY, Ivy Bank, Middleton Hall Road, King's Norton, Birmingham.—Mar. 2nd, 1918.—Relates to rubbing-collar devices for rotary pumps, of the kind in which the ring secured to the centre of a flexible diaphragm bears on a ring carried by the shaft. The pump spindle *a* has a flange *b*, recessed to hold a ring *c* of lignum vitæ, etc., on which bears a metal ring *d*



secured to a flexible diaphragm *e* of rubber, leather, or corrugated metal. The rings are pressed together by a spring *f* enclosed in a sleeve *k* and bearing on a plate *a* attached to the pump casing. The outer edge of the diaphragm is secured between plates *i*, *j*, one of which is screwed into the casing, a ring *l* being interposed to protect the diaphragm while the plate *j* is being screwed up.

INTERNAL-COMBUSTION ENGINES.

120,866.—S. Z. HALL, 76, Victoria Works, Westminster, and H. J MARSHALL, Britannia Ironworks, Gainsborough, Lincolnshire.—



July 31st, 1918.—A valve *a* for supplying compressed air or gas to the engine is actuated directly by a speed-controlled member, so that the valve remains closed when the engine exceeds a given speed. In the form shown, the valve is actuated from the direct

or reverse cam e or $e1$ through a spring-controlled rod g having a pivoted link h held by an adjustable spring against a fixed block k, the link h acting as an inertia tappet. In a modification, the link h is connected to a governor. The cam e, $e1$ is axially displaceable for reversing.

STEAM GENERATORS.

120,938.—G. R. WHITTAKER, 4, Clarkholme Street, Waterfoot, near Manchester, and J. YATES, 5, Byrom Street, Woolfold, Bury, Lancashire.—Feb. 7th, 1918.—A gas-tight joint between the back of a Cornish or like boiler and a side wall of the downtake is formed by plates d, e sliding in a channel or box in the wall, the rear plate d being capable of moving vertically as well as backwards and forwards, so that, by its weight, it presses the front

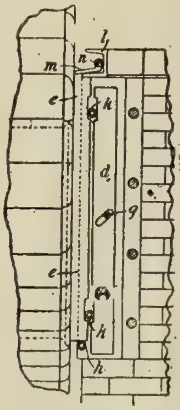
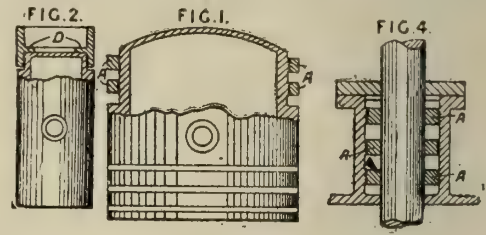


plate e against the back of the boiler. The rear plate is supported on a roller g engaging in an inclined slot in the plate. The front plate rests on a roller h. Rollers k between the plates allow relative vertical movment of the plates without friction. The joint at the top of the downtake is formed by a plate m resting between the back of the boiler and the bottom of a channel-iron l. Rollers n are provided on the edge of the plate resting against the channel-iron.

PISTON PACKING; STUFFING-BOXES.

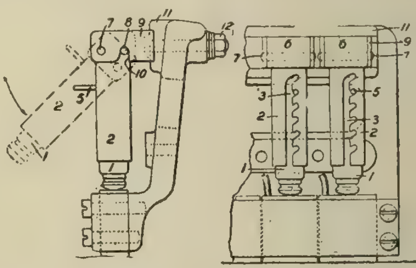
121,022.—T. D. KELLY, 19, Wilbury Crescent, Hove, Sussex.—Jan. 18th 1918.—A split packing-ring A is provided with a screw-thread on the inside which engages a screw-thread on the piston. A converse arrangement is adapted in a stuffing-box, Fig. 4, or in a cylinder wall with a piston or piston-rod passing through. In the case of a stuffing-box forming part of the cylinder cover, the ring may have a flange making a joint with the cylinder end. A split L-shaped packing-ring provided with a flange D is



screwed to the piston shown in Fig. 2. Asbestos or other packing may be arranged between the split rings and tightened by screwing them up.

DYNAMO-ELECTRIC MACHINES.

121,217.—PHŒNIX DYNAMO MANUFACTURING CO., Thornbury Works, Bradford, and A. H. BENNETT, 10, Wensley Avenue, Shipley, both in Yorkshire.—Jan. 26th 1918.—Relates to brush-holders in which each brush is fed forward against the



commutator by a plunger 1 controlled by a spring enclosed in a tube 2 with a longitudinal notched slot 3 coacting with a pin 5 on a plug behind the spring for adjustment of the pressure, and consists in arranging the head-piece 6 of the tube so that the plunger 2 may be swung away when required but is kept in true radial position when in action. Each head-piece 6 is pivoted on a pin 7 to a bracket 9; and carries a second pin 8 which rests in a slot 10 in the bracket when the tube 2 is in normal radial position. The brackets 9 are let into slots in the brush frame 11 and are held in place by bolts 12.

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CONTENTS.

EDITORIAL.

MECHANISM AND INDIVIDUALITY.

THERE exists an opinion common enough to warrant notice that modern industry, unlike the handicraft of former days, affords little opportunity of individual expression, and on that account its influence saps individual sincerity; some critics go so far as to assert that most industrial troubles spring from this cause. There is doubtless some ground for the assertion until it is analysed; such opinions are founded upon superficial and incomplete diagnosis, mainly by academic minds, whose production experience is a minus quantity. In every age the greater majority have been denied the chance of expression, of which the artist, architect, engineer, and the skilled craftsman are outstanding examples. It is not too much to say that, in industrial pursuits at the present time, there exists a greater number than ever before, who are afforded the coveted opportunity of individual expression. A distinction must be drawn between the chance and the desire; at least half those who have the opening are apathetic, or, what is worse, do not see their chance—those who will not seize, and those who will not see, form the majority. Neither brilliant gifts nor academic distinction are in themselves enough, it is more the will to wrest circumstance to advantage which counts. The man who despises his present task because he is superior is not the stuff to gain a reputation for special knowledge; in place of building fibre through detail attention, he is losing substance daily. There is chance concealed in the most humdrum occupation viewed rightly. Most big things arose from small beginnings, and the greater still contains the less.

The reaction of work upon the individual is profound, the reaction of the individual upon his work is not less deep because more visible; the first deserves consideration, but the latter is under everyone's control. No man worth his salt desires an easy task; those who have any ambitition want something to exercise their faculties, and the only sure road is distinction in their present job. The prescription may not please, but it has proved certain times out of number. Everyone responsible for production laments the numerous company who work solely for release, whose entire object is not the job in hand but the wage payable for time worked, with the half-hearted service such an attitude implies. These impedimenta were as well-known in past centuries as now, otherwise several antique proverbs have no meaning. The present trouble is that such a spirit has infected larger numbers, and its prevalence just now is striking. It is not so much lack of individual expression as disinclination to effort which troubles the national waters. No one can be indifferent to earning power; the fact is that the class cited are indifferent to work; sincerity has never been a virtue, just now its absence is marked. The age now closed, which came to an end in 1914, had, as its predecessor, one in which certain beliefs were held which now require re-emphasis; no one wishes to restore conditions which were self-condemnatory, but it was at least a time when self-indulgance was not tolerated, in theory at all events. We cannot go back, that is the last of our thoughts, but the present ideas lead surely to retrogression, for sheer idleness under whatever cloak cannot give prosperity, and in itself is harmful; work and play in full measure are both enjoyable, but it is the man who works who finds the spell of play the more enticing. As a nation we have to relearn the lesson that

subsistence comes first, not last, unless we desire to grind under the load of dire poverty.

It is to the individual that the future must look; unless all realise this fundamental, it will be useless to upbraid destiny when the pinch comes, just as useless as in the case of the man who finds no interest in his job, who is neglectful of opportunity and opening, when he cannot understand his want of personal success. The greater complexity in modern industry affords narrower limits, but the less the range the larger the numbers who have individual chances of expression. No one mind can compass any modern industry in its entireity; for this reason any main subdivision gives openings denied when control could be more complete. The need for individual expression troubles only a minority more's the pity, the rest prefer to keep on keeping on, the unusual oft gets short shrift; thought and individual opinion never having cultivitated, ridicule is meeted out instead of praise.

Some of these strictures apply generally, some must be qualified when applied to the world of mechanism in which there can never be any lack of opportunity for individual expression; the man at the drawing board and the man at the bench have this much in common. Engineering art is the keystone upon which all modern industry is based. The joy of craftsmanship and all it implies is still open to all its ranks, all in association have at least the chance of improving detail; it is a bounden duty laid on each, and in this respect the business has never yet been wanting. Unless all take a hand the passengers are more numerous than the motive forces, and the world at large is the poorer for want of realisation.

Every piece of mechanism is, in its main features, the expression of one man; equally and exactly it is the expression of many minds, it functions at first irregularly, but its improvement takes time and evolution, and it is always impossible to say it is fixed beyond hope of alteration for the better. Many hands wrought out its visible form with skill and cunning, so that from the first to last it is expression made manifest to view.

As with the machine, so with the man; the builder is more than the thing created, the reaction is mutual not separate. Since the human is more than the material, it follows that the want deplored by the critic does not apply to the premier profession of an age distinguished by many outstanding features. Even now, when industrial troubles are paramount, there is little need for despair; after all, we are common partners in a common weal, and when the truth sinks a little deeper the will to effort will be restored. It needs patience to restore normal conditions, but there are indications stability is approaching, although it may not take quite the form we hoped.

Sweden's Coal Requirements.—Mr. G. K. Hamfeldt, President of the Oxelösund Iron Works Co., was in Pittsburg recently, says *The Iron Age*, to investigate the matter of buying coal for cooking purposes, for a plant of 60 Koppers by-product coke ovens,, which his company operates in Sweden. Mr. Hamfeldt, however, found that prices of coal in Pittsburg were so high, and freights to Sweden so excessive, that it was not feasible to buy coal in the Pittsburg district, and it is undertood that he did not make any purchase. Mr. Hamfeldt was for some years superintendent of the Carrie blast-furnaces of the Carnegie Steel Co., Rankin, Pa.

HEAT APPLIED TO ENGINEERING.

By Prof. W. W. Haldane Gee, B.Sc., M.Sc.Tech.

(*Continued from page 455.*)

Specific Resistance and Temperature of Alloys.

For the purposes of electric heating the wires that are used may be raised to a temperature of 1,000° Cen. and higher. This will result in a very different specific resistance to that for the lower temperatures. To determine its value the α and β coefficients must be known, or a curve should be made use of which shows the specific resistances for a range of temperatures. Generally only the α coefficient is known, which may be used to find the specific resistance up to, say, about 60° Cen. For higher temperatures an approximate average number is sometimes applied. For example, the temperature coefficient of a nickel-chrome alloy is given as 0·00024 per degree Fah., but the makers of this alloy tabulate the resistance of 1,000 ft. of the wire of 0·04 inch diam. as 407 ohms at 475° Fah. and 415 ohms at 575° Fah. These figures give an increase of eight ohms for a rise of 100° Fah., and a temperature coefficient of 0·000196 for this range of temperature. The exact laws of change of resistance with temperature require investigation for a number of alloys.

Resistance and Length of Wires.

When the specific resistance is known, the ohms for any length L of wire of diameter d can be obtained from the formula :—

$$R = \rho \frac{L}{\pi/4 \ d^2}$$

If d is the diameter in the B. & S. gauge then the resistance of four successively smaller wires will be in the ratio of $1 : 2\frac{1}{3} : 2\frac{2}{3} : 2$. The doubled value of the fourth number is especially useful in checking tables issued by wire makers.

Example.—Check the following figures for nichrome wire whose specific resistance is given as 600 ohms—circular mil.—foot.

No. B. & S.	Diameter.		Ohms per	
	Inch.	Mm.	1,000 ft.	1,000 metres
1	0·289	7·341	7·1	23·3
2	·258	6·553	9·0	29·6
3	·229	5·826	11·4	37·4
4	·204	5·190	14·4	47·3
5	·182	4·169	18·1	59·5
6	·162	4·115	22·8	74·8

Answer.—It will be observed that in both systems of units Nos. 1, 2 and 3 are approximately half of Nos. 4, 5 and 6 respectively. A nearer result would require that the sizes of the wires should be stated more accurately. To check the 7·1 ohms per 1,000 ft. we have :

$$R = 600 \times \frac{1000}{(289)^2} = 7·18 \text{ ohms.}$$

No. 1 in metric units will be :—

$$R = \frac{600}{6·014} \times \frac{1000 \times 1000}{\pi/4 \times (·7341)^2 \times 10^6} = 23·2 \text{ nearly,}$$

where $6·014 \times 10^6$ converts from ohms—circular mil.—foot to ohms—square cm.—cm.

Length and Weight of Wire.

For the cm.—gram system of units we have :—

$$M = L A \Delta$$

where M is the weight in grammes, L the length in cms., A the area in sq. cms., and Δ the density of the wire. If L be 1000 metres, then the weight W in kilos. is :—

$$W = \frac{1000 \times 100}{1000} A \Delta = 100 A \Delta$$

$$= \frac{100}{4} \pi d^2 \Delta = 25 \pi d^2 \Delta$$

d being the diameter of the wire in cms.

Using British units and calling k the weight of a cubic inch of the wire in lbs., then the weight W_1 in lbs. per 1000 ft. is :—

$$W_1 = 1000 \times 12 \times \frac{\pi}{4} d_1{}^2 k = 3000 \pi d_1{}^2 k,$$

d_1 being the diameter of the wire in inches.

Example.—Check the following table assuming $\Delta = 8{\cdot}15$, and $k = 0{\cdot}29$.

No. B. & S.	Diameter.		Weight.	
	cms.	inches.	kilos. per 1000 metres	lbs. per 1000 ft.
7	0·3665	0·144	85	57
8	·3264	·128	67	45
9	·2906	·114	53·5	36
10	·2588	·102	43	29
11	·2304	·091	34	23
12	·2052	·081	26·7	18

Answer.—By inspection the sequence of the numbers, as in the last example, is seen to be approximately followed. For No. 7 we have :—

$W = 25\pi \times (\cdot 3655)^2 \times 8{\cdot}15 = 86$ kilos. per 1000 metres,

and $W_1 = 3000\pi \times (\cdot 144)^2 \times \cdot 29 = 57$ lbs. per 1000 ft

Length of Wire in Spirals.

When a helical coil is closely wound so that the turns touch each other, then the number of turns in a length of coil l will be l/d, where d is the diameter of the wire. If the spirals have been wound on a mandril of diameter D, the length of wire on each turn will be πD, and the total length L of the wire will be :—

$$L = \frac{\pi l D}{d}.$$

If the spiral be pulled out so that there is an insulating air space between the turns, then d in the above formula must be increased to $n\,d$ where n is some multiplier.

Example.—Verify the following numbers taken from the tables issued by the Concordia Electric Wire Ltd.:—

No S.W.G.	Diameter of Wire.	Diameter of Mandril.	Feet per inch. closed coil.	Times coil extended	Length of extended coil.	Feet of wire on extended coil.
	inches	inches.			inches.	
8	0·160	1	1·63	$1\frac{1}{2}$	15	16·2
11	·116	$\frac{7}{8}$	1·98	2	15	14 8
14	·080	$\frac{3}{4}$	2·44	$2\frac{1}{2}$	12	11·7
20	·036	$\frac{1}{2}$	3·65	4	9	8·3
22	·028	$\frac{1}{2}$	4·66	4	9	10·5

Answer.—For No. 8.

Length of wire on closed coil $= \frac{\pi \times 1 \times 1}{\cdot 16 \times 12} = 1{\cdot}64$ ft.

Length of wire on extended coil of 15 in. length ..... $= \frac{\pi \times 15 \times 1}{\cdot 16 \times 1{\cdot}5 \times 12} = 16{\cdot}4$ ft.

For No. 20.

Length of wire on closed coil $= \frac{\pi \times 1 \times \cdot 5}{\cdot 036 \times 12} = 3{\cdot}64$ ft

Length of wire on extended coil of 9 in. length ...... $= \frac{\pi \times 9 \times \cdot 5}{\cdot 036 \times 4 \times 12} = 8{\cdot}2$ ft.

In a similar way the other figures can be confirmed. It should be stated that this method of calculation is only approximate, but it is sufficiently accurate for all technical purposes.

(To be continued.)

70,000 K.W. TURBO GENERATOR.

The Interborough Rapid Transit Co., New York, says *Electrical Review*, Chicago, has recently placed in operation at its Seventy-fourth Street power house a turbine which is rated at a 60,000-kw. capacity continuously, and 70,000 kw. for two hours, it being, therefore, the most powerful prime mover in the world. It has three elements—one high-pressure and two low-pressure—and is the first triple cross-compound turbine to be placed in operation. It will assist in meeting the greatly-increased demand for transportation in New York City, due to the opening up of a new subway system and the extension of the service of the existing subway, elevated, and subway lines. The machine, though consisting of three separate elements, is started, synchronised, and controlled as a single unit. All of the turbines are of the pure reaction type, without the usual impulse elements, a form of construction considered preferable in view of the great volumes of steam to be handled. The high-pressure turbine is of the single-flow type, and is of cast-steel. The low-pressure turbines are of the series-double-flow type; that is, the steam enters near the centre of the turbine and flows as a whole through a portion of the blading and then divides into two portions, each of which flows through a separate section into the condenser. Since the low-pressure turbines must take high-pressure steam in case the high-pressure turbine is shut down, the central portion of these turbines are made of cast steel also. All these rotors are equipped with Kingsbury thrust bearings.

Famous Motor-Cycle Race Revived.—The famous Johannesburg-Durban motor-cycle race was revived this year. One of the most strenuous races in existence, the results of this race are always keenly watched. A significant fact of this year's race is that out of the 15 machines that finished, the first, second, fourth, and eight others were fitted with Bates' Tyres—a remarkable proof of value.

H. Mason and Sons Ltd. (157,900).—Private company. Registered August 13th. Capital £12,000, £1 shares. To take over the business carried on at Camp Hill Works, Stanhope Street, Birmingham, as "Mason Bros.," and to carry on the business of manufacturers of and dealers in nuts, bolts, screws, pins, studs, rivets, steel toys, accessories for cycles, motor cycles, motor cars, aeroplanes, airships, boats and ships, etc. Directors appointed by subscribers. Registered office : Camp Hill Works, Stanhope Street, Birmingham.

STEAM SUCTION ASH CONVEYOR.

[ED. BENNIS AND CO. LTD., LITTLE HULTON, BOLTON.]

THE question of dealing economically with the ash and clinker produced in boiler houses is one that concerns all power users. The difficulties and cost of labour are very considerable, and in consequence special plant has been designed to reduce handling as far as possible. What is to us a new form of ash and clinker conveyer has recently been introduced by the above firm. It is a steam suction conveyer extremely adaptable to confined spaces. It is not necessary to provide a large ash hopper or receptacle to take the ashes, as they may be discharged, if desired, into a piece of waste land or field adjoining the factory or direct into a railway wagon or cart.

The conveyer consists of a heavy cast-iron pipe line, made of special hard mixture, for the manufacture of which the above firm have laid down special plant. The pipes are fitted with their patented bends, tees, and corner pieces, which have renewable chilled metal wearing parts.

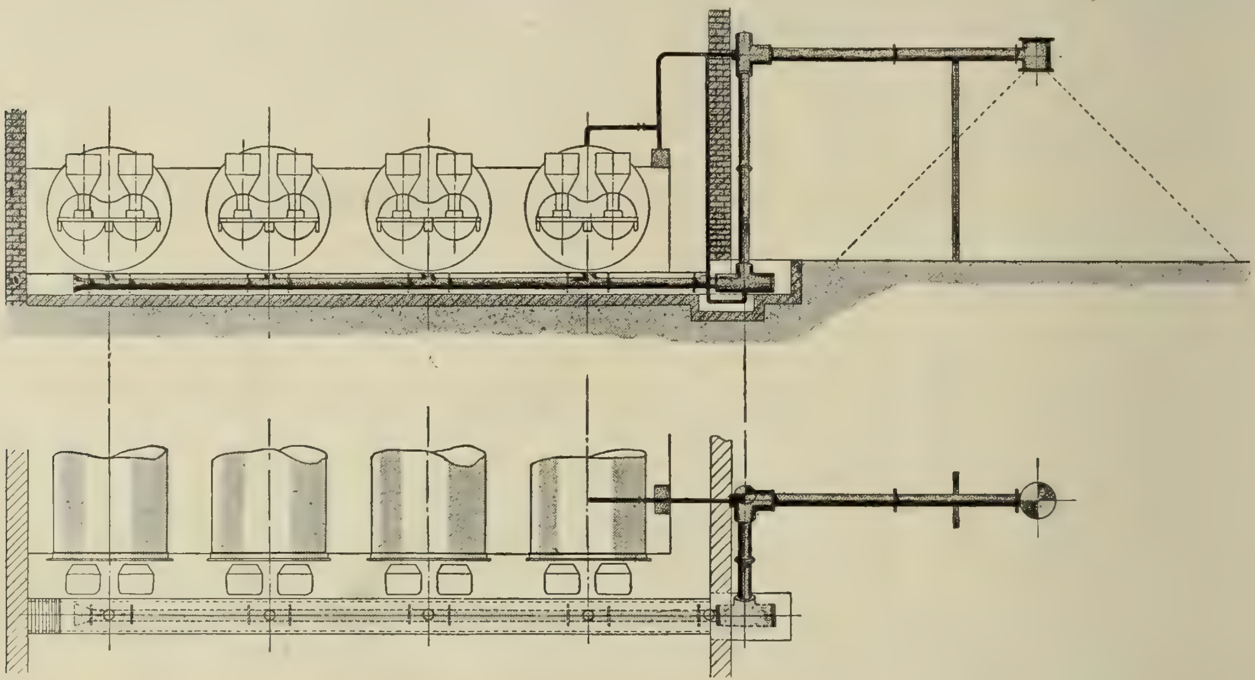


FIG. 1.—"Bennis" steam jet conveyor delivering ashes into heap in yard. Front elevation and plan.

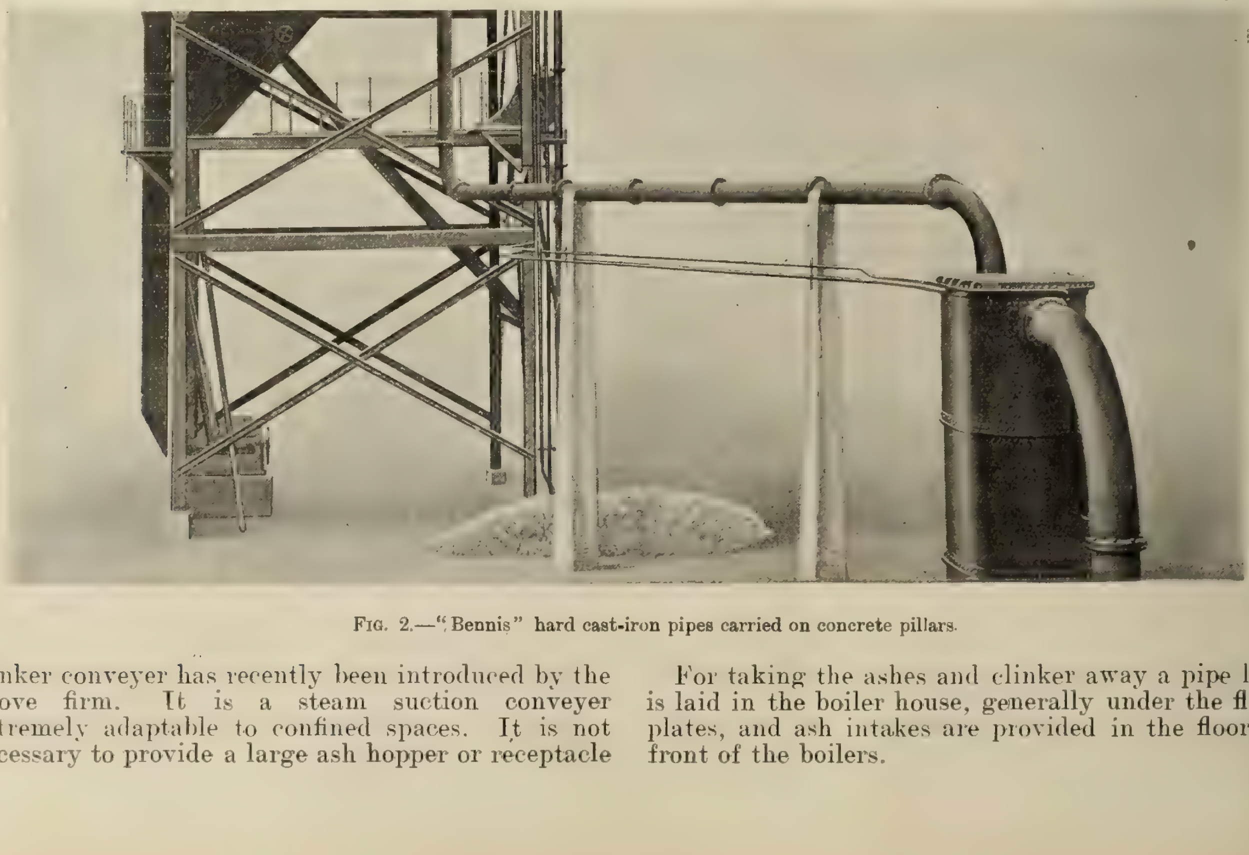


FIG. 2.—"Bennis" hard cast-iron pipes carried on concrete pillars.

For taking the ashes and clinker away a pipe line is laid in the boiler house, generally under the floor plates, and ash intakes are provided in the floor in front of the boilers.

Six-inch or eight-inch pipe lines are the sizes most in demand; the latter is generally considered the most convenient, as it will take the larger lumps of clinker. The ash is raked into the pipe through holes provided with hand valves.

The economisers and flues can be cleaned by similar means, branch lines of smaller size, usually 4in. diameter, being used for this purpose.

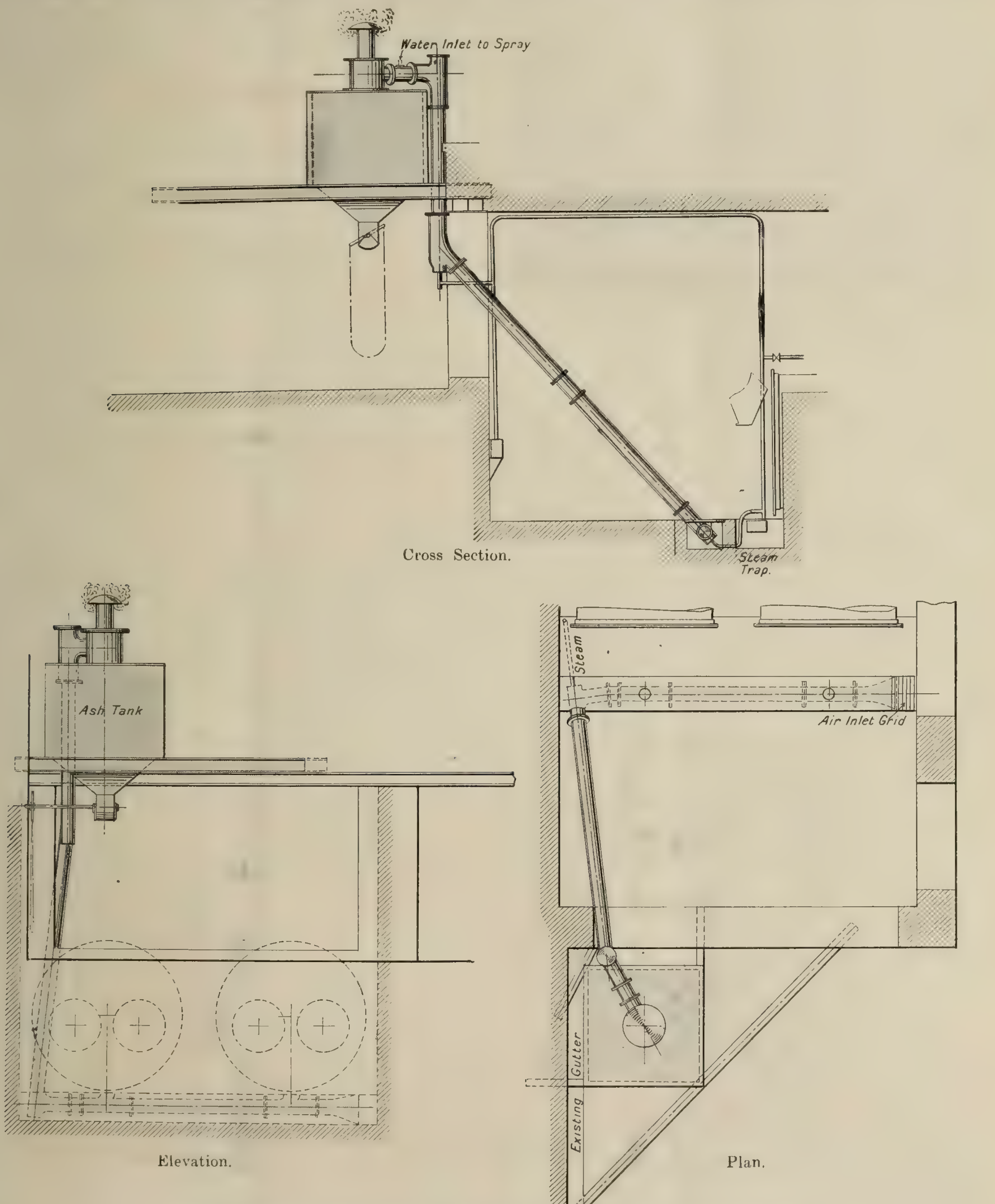


Fig. 4 —" Bennis " steam jet conveyor serving two Lancashire boilers and delivering ashes into overhead ash storage tank.

The steam valve being opened, the ashes are raked into the intake of the conveyer, and conveyed by

means of the suction created to the desired point, such as an overhead hopper. From this hopper the ashes can be removed as desired.

The ashes can be elevated to a considerable height

FIG. 3.—"Bennis" ash plant, showing pipe arrangement and a receiver tank.

and can also be carried comparatively long distances, say, from 200 ft. to 300 ft. from the boiler house.

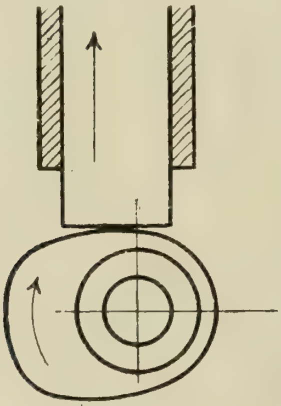
There are no moving parts, so that wear and tear are reduced to a minimum.

CAMS.

By W. E. BENNISON, A.M.I.M.E.

(*Continued from page 454.*)

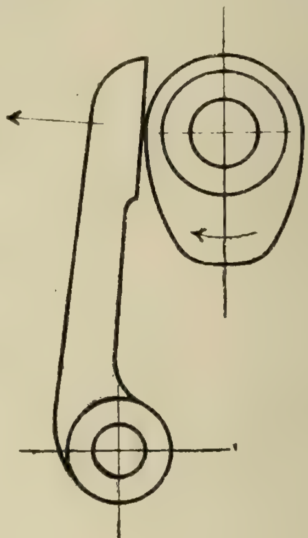
Fig. 13. *Spiral cam, surface contact: Straight line motion away from axis.*—The actuated member in this case is a sliding bar similar to Fig. 6, but instead of there being a roller the cam presses against the flat end of the bar and pushes it away from the axis. The bar would be returned by a spring, or weight, &c. The cam face does not always press against the same point, but the point of contact may travel along the surface



CAMS.—FIG. 13.

as different portions of the cam bear against it. The surface must always be a tangent to the cam curve for any position of the cam. The surface must therefore be ample enough to give this condition, and if it is not practicable to make the bar wide enough the end in contact with the cam would have to be thickened up, or a plate fixed on to it.

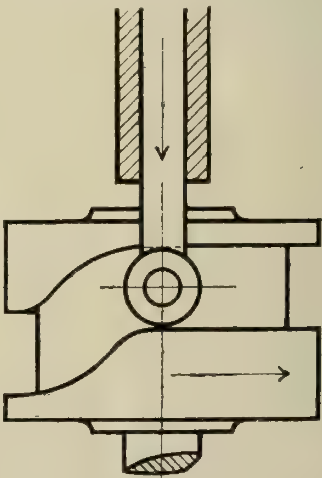
Fig. 14. *Spiral cam, surface contact: Angular motion in one direction.*—In this example the surface is shown to be part of the free end of a lever which is fulcrumed to the framework or other part of a machine. It is convenient to make the position of the surface such that if produced it would pass through the fulcrum, but this is not a necessary condition. The surface is pushed away from the cam axis and the lever caused to rotate about its fulcrum. As before, the return stroke must



CAMS — FIG. 14.

be made by external means. The remarks which were made about the contact surface in the last example apply also to this one. The surface will always be tangent to the cam curve, but in this case the various positions will all radiate from the fulcrum, instead of being parallel to each other.

Fig. 15. *Helical cam, roller contact: Straight line motion in two directions, parallel to axis.*—The cam is shown as a cylinder mounted upon a shaft, the axes of

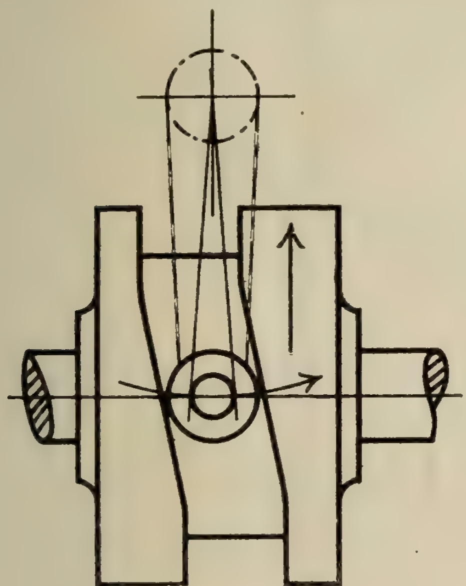


CAMS.—FIG. 15.

both cylinder and shaft coinciding. Right round the periphery of this cylinder is cut a cam groove into which the roller just fits. The roller is carried by a sliding bar as in Fig. 6, the direction of motion being parallel to the cam axis. The cam is a double-acting one, for each side of the groove forms a cam surface which acts upon the roller: the cam surface on one side of the

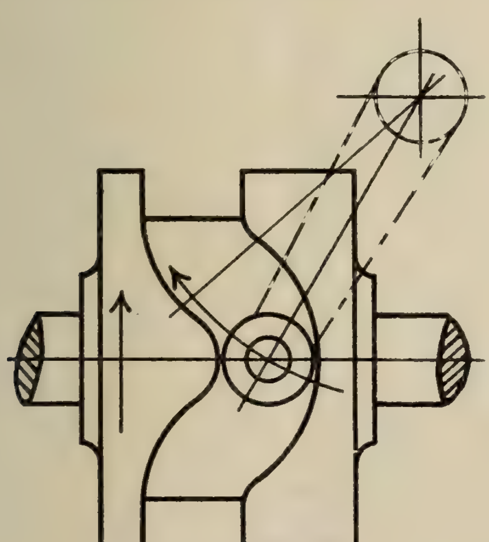
groove forces the roller in one direction, and the cam surface on the other side of the groove forces the roller in the contrary direction: thus for one revolution of the cam the sliding bar make one reciprocation.

Fig. 16. *Helical cam, roller contact: Angular movement in two directions.*—The cam is similar to the last



Cams.—Fig. 16.

one, the groove being cut right round the cylinder. The roller is carried by the free end of an oscillating lever, the lever being shown in dot and dash to avoid interfering with the cam. Under the conditions here shown, *i.e.*, with the lever approximately at right angles to the cam axis, and the movement of the follower small, the motion given to the follower approximates to that of straight

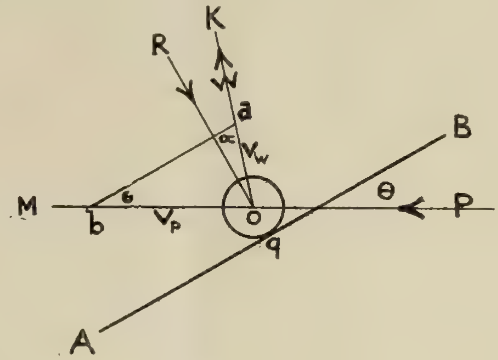


Cams.—Fig. 17.

line motion; the motion given to the lever is, however, angular.

Fig. 17. *Conditions similar to Fig.* 16 *but position of lever changed.*—The normal position of the lever is inclined to the cam axis and the motion of the roller is by no means parallel to it, in fact, the path of the roller centre will intersect the vertical plane through the axis. As in the case of the spiral cam this inclined position of the lever will influence the shape of the cam curve.

In all the foregoing examples except two the follower is in the form of a roller. The principles, however, are exactly the same if the follower takes the form of a round peg or a pivoted block. The true cam curve passes through the centre of the roller, the actual cam curve being parallel to the true one and distant from



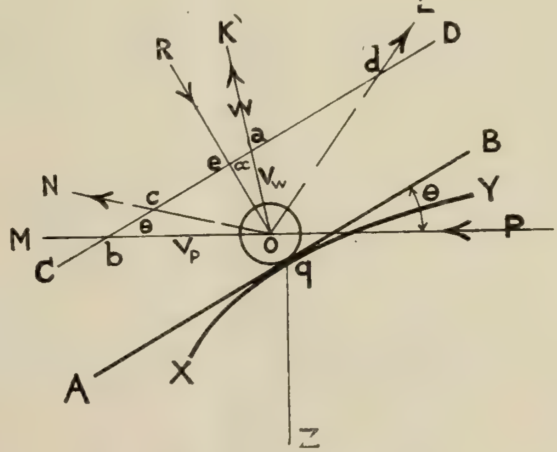
Cams.—Fig. 18.

it by the radius of the follower. By some, the true cam curve is called the "pitch curve." If the follower were merely a line or point the true and the actual curves would coincide, but this condition is not possible in practice.

In the case of surface contact the surface is always tangent to the cam curve and the actual curve is also the true one.

Forces Acting on the Follower.

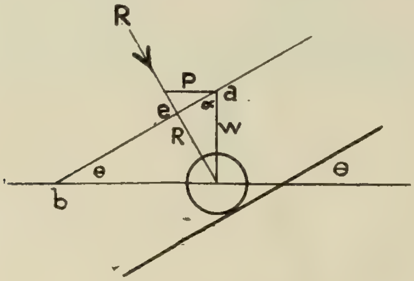
It was said that the mechanical principle governing cam action is that of the wedge. Fig. 18 shows a wedge acting upon a roller. A B represents the inclined face



Cams.—Fig. 19.

of the wedge and it is supposed to be moving in the direction P M. O is the centre of the roller and q the point of contact. Normally, the roller will tend to travel in the direction O R at right angles to A B, but it can be constrained to move in any direction: let the point O therefore move along the path O K.

Fig. 19 shows a cam surface X Y acting upon a roller, q being the point of contact and O the centre of the roller. If the cam is a spiral one let Z be its axis. Join Z q, and the direction of motion of the cam surface will be at right angles to Z q, say along P M. If the cam is a helical one the direction of motion will be at right angles to the axis and can assumed to be in the direction P M. In either case, at the particular instant under consideration, the surface X Y may be supposed to be moving in the direction P M. If a tangent A B is drawn through q the conditions will be exactly the same as in Fig. 18, in fact, the two figures are made exactly



CAMS.—FIG. 20.

similar. At the point q the tangent A B can be imagined to act upon the roller as a wedge, driving it in the direction O K. Let P = the driving force on the wedge, and W = resistance of the roller to move along its path, which may be called the load. On O M mark off a part O b to represent the velocity of the wedge in the direction O M. Through b draw C D parallel to the tangent A B and cutting O K in the point a : then the distance O a will represent the corresponding velocity of the roller centre along O K. If any other direction for the follower had been taken such as O N, O L, the intercept of these lines from the point O by the line C D will give the velocity of the follower in the required direction, viz., O c along O N, and O d along O L.

Let the angle θ = the slope of the curve at the point q, which is sometimes called the wedge angle, and let α = the angle included between the tangent A B and the follower path such as O K. If V_p = the velocity of the wedge and V_w = the velocity of the follower, then

$$\frac{V_p}{V_w} = \frac{\sin \alpha}{\sin \theta} \text{ or } V_p = \frac{V_w \sin \alpha}{\sin \theta}.$$

The forces P and W will, of course, be inversely proportional to the velocities, therefore

$$P = \frac{W \sin \theta}{\sin \alpha}.$$

When α becomes 90 deg., that is, when the direction of the follower motion is at right angles to the tangent; W becomes the greatest possible and

$$P = W \sin \theta.$$

Under these conditions the greatest possible mechanical advantage is obtained from the wedging action of the cam surface.

When $\delta + \alpha$ becomes 90 deg. the motion of the follower is at right angles to the direction of the driving force and

$$P = W \tan \theta.$$

Fig. 20 shows this special case, which is a very common one.

The re-action R of the follower against the cam is at right angles to the tangent and its velocity is represented by O e (Fig. 19).

Fig. 20 is a diagram of forces, the forces being proportional to the sides of the triangle ; from it

$$R = \frac{P}{\sin \theta}.$$

The greatest friction acts along the tangent and varies inversely as the sin of the wedge angle. The retarding force along the tangent F = μ R where μ = the coefficient of friction, that is—

$$F = \frac{\mu P}{\sin \theta}.$$

Resolved in a direction M O opposite to the driving force the retarding force would be—

$$\text{Retarding force} = F \cos \theta = \frac{\mu P \cos \theta}{\sin \theta} = \frac{\mu P}{\tan \mu}.$$

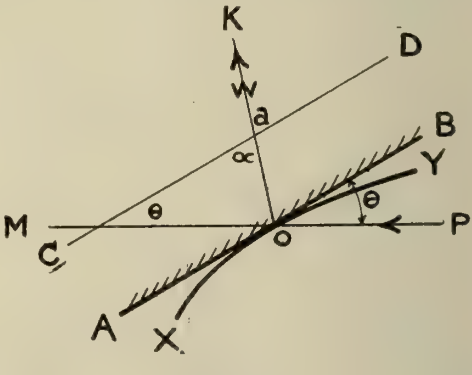
The total driving force Q required will therefore be

$$Q = P + \frac{\mu P}{\tan \theta}.$$

If r is the distance of the force P from the axis of the cam in inches and if P is in lbs., the driving torque required will be—

$$\text{Driving torque} = Q\,r \text{ inch lbs.} = r\left(P + \frac{\mu P}{\tan \theta}\right) = P\,r\left(1 + \frac{\mu}{\tan \theta}\right) \text{inch lbs.}$$

In the case of surface contact the conditions of equilibrium will be exactly the same as for roller contact, which has just been dealt with. For the sake of clearness, however, the conditions for surface contact have



CAMS.—FIG. 21.

been shown separately in Fig. 21. The only difference between this diagram and Fig. 19 is that the points O and q will now coincide. X Y is the cam curve and it is moving in the direction P M. There is no need to draw a tangent this time because the surface itself A B is the tangent. O is the point of contact, and the whole surface A B is imagined to be moving in the direction O K. The construction is now exactly as in Fig. 19, the distances Oa, Ob representing the velocities V_w, V_p, or the forces P and W. The formulæ deduced from Fig. 19 hold good for Fig. 21 and the lettering is exactly the same.

(To be continued.)

OIL SHALES.

(Concluded from page 445.)

In the distillation of oil-shales there are four primary products, namely, oil, gas, water and spent shale. The character of the oil will vary somewhat with the character of the original shale, as, for example, the shale-oil from the shale near Elko, Nev., is much higher in paraffin than most of the shale-oil that has been produced by the same methods from shale of the Uinta Basin in Colorado and Utah, but the greatest differences that will be found in the shale-oils are likely to be due to the conditions under which the shale is distilled.

Gas will be made in the retorts which will not be condensed to oil. This will contain ammonia, which can easily be extracted and converted into commercial ammonium sulphate, which is valuable as a fertiliser. The average nitrogen content of shales of the Green River formation yielding more than 15 gallons of oil per ton is theoretically equivalent to about 50 pounds of ammonium sulphate per ton shale, and, of this, commercial practice should recover at least 60 per cent, so we may expect that our shales will yield at least 30 pounds of ammonium sulphate from each ton of shale distilled.

Nearly all rocks contain water, and oil-shale is no exception, and in their distillation for oil the water will, of course, be vaporised and condensed along with the oil. It has been found in the Scottish practice that the recovery of nitrogen from the shale is assisted by the addition of water or steam to the shale while it is being heated, and if this is found advantageous with the American shales the amount of water which is discharged from the condensers will, of course, be large. This water should contain most or all of the ammonia which is formed in the retort by the decomposition of the nitrogenous compounds in the shale .

One of the great problems connected with the recovery of the valuable products from oil-shale will be that connected with the ash or spent shale. In the small testing apparatus some of the richer shales have been found to fuse and slag together and their removal from the retort thus made difficult. In the larger retorts it may be found that the injection of steam into the heated shale within the retort will help prevent his caking as well as help to secure the maximum recovery of the nitrogen of the shale, or it may be found necessary to agitate the shale while it is being treated, or even mix the rich shale with leaner material. These are some of the problems to which the chemist and engineer must give attention. Furthermore, it is to be expected that the satisfactory operation of a given apparatus using one type of shale will not constitute proof that the same machine will produce equally good results from all oil-shale. For instance, the methods and apparatus found efficient for the mining and treatment of the oil-shale from near Elko, Nev., will doubtless have to be greatly modified before they will produce good results when used in connection with the shales of north-western Colorado.

So far as at present known there seems to be little proof that valuable substances remain in the spent shale, and since a plant which is built to handle 1,000 tons of raw shale per day must handle and dispose of probably 600 tons of waste material whose bulk is only slightly less than the original shale, the problem of the disposal of this spent shale is one which must be solved before the plant is established, as ample dumping ground must be available. It has been suggested that this waste might contain potash or phosphate, but none of the samples so far analysed by the Geological Survey have been found to contain sufficient soluable potash to warrant a quantitative determination, and only the black shales of the Phosphoria formation of western Montana have been found to have a high percentage of phosphate in combination with oil-yielding ability.

Reports that oil-shale was rich in gold, silver, lead, zinc, platinum, etc., have been circulated and have attracted much attention, but to anyone who is familiar with the conditions under which such metals accumulate the chances seem very small for finding commercial quantities of shale which will yield values in these elements. I have been informed that in a large number of samples assayed by the University of Colorado some of these metals have been found, but in no sample was the combined value for the metals found to be much more than 4s. per ton.

Chemists experimenting with the oil-shale and the shale-oil produced from them are making many and varied products—rubber substitutes for use in automobile tyres, gaskets, and other places; beautiful dyes and powerful explosives; paints and many other interesting things, but the great question is not what is it possible to make, but what can be manufactured profitably. Again, we must wait for answer till shale-oil is being produced commercially.

Like all new enterprises, there are any number of ideas as to the correct way to treat oil-shale to get the best results. I have had the privilege of seeing the designs of many of these processes and of seeing the machinery installed for a few of them, and I will give a brief outline of the principles of those which I have seen, more to illustrate the widely divergent ideas than to give details of the processes.

One of the first plants erected and tried out on the western oil-shale consisted of a metal tube about 30 feet long and a foot in diameter set in a brick fireplace and inclined at an angle of about 10 deg. to the horizontal. Partially crushed shale was fed into the tube at the lower end and carried slowly upward through the retort by a screw conveyor and discharged at the upper end. Heat was applied to the retort about midway between the ends, so that in travelling the length of the tube the shale was gradually heated to red heat and then gradually cooled till it could be easily handled at the discharging end. The volatile products are removed by slight suction at the intake end of the retort.

A second process consists in a metal chamber or retort, cylindrical in form and standing on end. Raw shale is fed into the top and passes downward and at the same time the temperature is increased. The lighter hydrocarbons are supposed to be distilled off from the shale in the upper part of the retort and the heavier hydrocarbons used for fuel in the lower end of the same retort where the half-spent shale is burned.

One retort which is being installed by several companies with properties near De Beque, Colo., consists of an inclined trough with cover, set in a brick oven. The cover is equipped with numerous

exit tubes through which the volatilised products of the distillation are allowed to escape to the condensers. Finely crushed shale is fed into the upper end of this retort and conveyed down by a mechanical agitator. The maximum heat is applied to the lower end of the retort, so that the temperature to which the shale is subjected increases as the shale travels down the 30-ft. long retort. The numerous exit tubes are supposed to allow partial fractionation of the oil as it is formed.

Still another distilling apparatus which has been tried out consists of three iron tubes placed horizontally one above the other and communicating at alternate ends. Shale is fed into the upper tube and conveyed through the three consecutively by screw conveyors. Each tube is provided with exit for the gases evolved in it and these are condensed separately, so that at least theoretically there is a three-part fractionation of the crude shale-oil as it comes from the retort. Heat is applied to the lower tube and conducted beneath the other tubes, so that the least amount is applied at the point nearest where the shale enters the system.

The retorts now used in Scotland are the growth of many years of experimentation. The earliest apparatus used there consisted in horizontal tubes, but these were soon discarded in favour of the vertical tubes, and at present the principal retorts consist of tall cylinders somewhat larger at the bottom than at the top and provided with no force but gravity to convey the shale from the top down to the point of exit after it is freed of its oil-forming substance. Some of the older vertical retorts were provided with internal agitators, but these were sooner or later discarded because the operation of metal parts in the highly heated chamber gave endless trouble. Heat is applied externally to the retorts, and the fixed gases from the shale provide ample fuel for the heating of the retorts. Gases are conveyed from the retorts into large air-cooled condensers consisting of many vertical tubes or pipes. After this such gas as is not condensed is scrubbed for ammonia by washing with water and for additional naphtha by washing with heavy oil. In the Scottish industry it has been found that the permanent gases are more than sufficient to heat the retorts.

Two processes are being perfected in America each of which uses modifications of the Scottish retorts, and each of these will use condensers of special design and radically different from the simple air-cooled condenser used in Scotland.

At least one retorting system proposed for our American shales embodies the principle of removing the gas from the centre of the shale chamber on the theory that this will prevent to a maximum degree the cracking of the oil into undesirable gases. In this machine heat is applied externally to the large cylinder containing the shale. In the middle of this cylinder there is a perforated exit pipe through which the gases are drawn off and sent to the condensers.

One of the most complicated retorts designed for the distillation of oil-shale comprises eight communicating chambers, four of which are provided with a hearth attached to a revolving shaft and four of which are furnace chambers into which the heat is applied. These heat and hearth chambers alternate one above the other; the shale entering the topmost chamber first is carried by a rotating agitation system across the first hearth and then consecutively to the second, third and fourth, the temperature being higher in each chamber. The vapours are removed from each chamber separately and condensed, so that the oil is partially fractionated as it comes from the retort.

Oil-shale, it has been said, is a rock from which the oil and other products may be distilled, but before the shale is ready to retort it must be mined like coal and crushed. Within the areas in the Rocky Mountain States that are underlain with rich oil-shale there are many small tracts where the shale is sufficiently close to the surface to be mined with a steam shovel, but most of these tracts are remote from transportation and therefore may not be used in the first stages of the developments. We must therefore now look carefully to the conditions that will affect the methods and expense of underground mining. The shale lies in "blanket form" like coal, and in most places the beds are practically horizontal, so that none of the difficulties incident to the mining of steeply tilted beds such as are met in the oil-shale industry of Scotland will be encountered. The rich oil-shale beds are usually overlain by beds which will not be affected by weather, so that little trouble is to be expected with roof. The shale may be harder to mine on account of its toughness, but machinery will be developed which will cut and drill the rock without difficulty. The cost of mining shale will be at least as great as the cost of mining coal in the same region.

After the shale is mined it must be transported to the retorts, and because of the fact that the shale beds outcrop high on the sides of mesas, in some places 2,500 feet above the sites which must be chosen for the retorting plants, this transportation will necessitate the installation of tramways in some cases a mile in length. Then the rock must be crushed to the appropriate size before it is ready to go to the retorts. The fineness to which the shale will be crushed depends upon the process that is adopted for its treatment. One of the methods proposed requires that the shale be crushed to a powder; others propose to handle shale almost as it comes from the mine. For the task of crushing the shale it may be necessary to design and construct crushers of special model, as there will be a tendency for the shale to gum and pack in the crusher.

At the present time there is no exact or satisfactory information regarding the cost of any of the phases of this new industry. The installation of a tramway system capable of delivering shale to a commercial sized plant will probably mean the expenditure of £3,000 or £4,000, and the crushers will cost money to instal as well as operate. The cost of a retorting system has been estimated at from £60 to £500 per ton of shale to be treated per day, depending on the system that is to be used. The cost of operating the apparatus after it is installed is, of course, as uncertain as the original cost of the plant because of the undeveloped stage of the machinery. The following figures showing the pre-war costs of the Scottish industry can, for want of better, be considered as the best figures available. The installation of a large Henderson retorting plant before 1909 was quoted as about £70 per ton daily capacity, and the cost of operation, including mining, crushing, with the production of crude shale-oil and ammonium sulphate, was 8s. 2d. for each ton of shale

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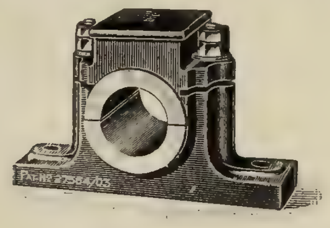

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Beam 10 in. × 5 in. × 33 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 3 22	5 3 16	8 3 10	11 3 4	14 2 26	0 17 2 20	1 0 2 14	1 3 2 8	1 6 2 2	0
1	0 1 5	3 0 27	6 0 21	9 0 15	12 0 9	15 0 3	0 17 3 25	1 0 3 19	1 3 3 13	1 6 3 7	1
2	0 2 10	3 2 4	6 1 26	9 1 20	12 1 14	15 1 8	0 18 1 2	1 1 0 24	1 4 0 18	1 7 0 12	2
3	0 3 15	3 3 9	6 3 3	9 2 25	12 2 19	15 2 13	0 18 2 7	1 1 2 1	1 4 1 23	1 7 1 17	3
4	1 0 20	4 0 14	7 0 8	10 0 2	12 3 24	15 3 18	0 18 3 12	1 1 3 6	1 4 3 0	1 7 2 22	4
5	1 1 25	4 1 19	7 1 13	10 1 7	13 1 1	16 0 23	0 19 0 17	1 2 0 11	1 5 0 5	1 7 3 27	5
6	1 3 2	4 2 24	7 2 18	10 2 12	13 2 6	16 2 0	0 19 1 22	1 2 1 16	1 5 1 10	1 8 1 4	6
7	2 0 7	5 0 1	7 3 23	10 3 17	13 3 11	16 3 5	0 19 2 27	1 2 2 21	1 5 2 15	1 8 2 9	7
8	2 1 12	5 1 6	8 1 0	11 0 22	14 0 16	17 0 10	1 0 0 4	1 2 3 26	1 5 3 20	1 8 3 14	8
9	2 2 17	5 2 11	8 2 5	11 1 27	14 1 21	17 1 15	1 0 1 9	1 3 1 3	1 6 0 25	1 9 0 19	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	
Weight.	0 2·75	0 5·5	0 8·25	0 11·0	0 13·75	0 16·5	0 19·25	0 22·0	0 24·75	0 27·5	0 30·25	0 33·0	Weight.

Weights of Lengths of Rolled Steel Sections.

Beam 10 in. × 5 in. × 33 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft
0	..	1 9 1 24	2 18 3 20	4 8 1 16	5 17 3 12	7 7 1 8	8 16 3 4	10 6 1 0	11 15 2 24	13 5 0 20	0
10	0 2 3 22	1 12 1 18	3 1 3 14	4 11 1 10	6 0 3 6	7 10 1 2	8 19 2 26	10 9 0 22	11 18 2 18	13 8 0 14	10
20	0 5 3 16	1 15 1 12	3 4 3 8	4 14 1 4	6 3 3 0	7 13 0 24	9 2 2 20	10 12 0 16	12 1 2 12	13 11 0 8	20
30	0 8 3 10	1 18 1 6	3 7 3 2	4 17 0 26	6 6 2 22	7 16 0 18	9 5 2 14	10 15 0 10	12 4 2 6	13 14 0 2	30
40	0 11 3 4	2 1 1 0	3 10 2 24	5 0 0 20	6 9 2 16	7 19 0 12	9 8 2 8	10 18 0 4	12 7 2 0	13 16 3 24	40
50	0 14 2 26	2 4 0 22	3 13 2 18	5 3 0 14	6 12 2 10	8 2 0 6	9 11 2 2	11 0 3 26	12 10 1 22	13 19 3 18	50
60	0 17 2 20	2 7 0 16	3 16 2 12	5 6 0 8	6 15 2 4	8 5 0 0	9 14 1 24	11 3 3 20	12 13 1 16	14 2 3 12	60
70	1 0 2 14	2 10 0 10	3 19 2 6	5 9 0 2	6 18 1 26	8 7 3 22	9 17 1 18	11 6 3 14	12 16 1 10	14 5 3 6	70
80	1 3 2 8	2 13 0 4	4 2 2 0	5 11 3 24	7 1 1 20	8 10 3 16	10 0 1 12	11 9 3 8	12 19 1 4	14 8 3 0	80
90	1 6 2 2	2 15 3 26	4 5 1 22	5 14 3 18	7 4 1 14	8 13 3 10	10 3 1 6	11 12 3 2	13 2 0 26	14 11 2 22	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft
	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	
Weight.	14 14 2 16	29 9 1 4	44 3 3 20	58 18 2 8	73 13 0 24	88 7 3 12	103 2 2 0	117 17 0 16	132 11 3 4	147 6 1 20	Weight.

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Weights of Lengths of Rolled Steel Sections.

Beam 8 in. × 6 in. × 34 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 0 4	6 0 8	9 0 12	0 12 0 16	0 15 0 20	0 18 0 24	1 1 1 0	1 4 1 4	1 7 1 8	0
1	0 1 6	3 1 10	6 1 14	9 1 18	0 12 1 22	0 15 1 26	0 18 2 2	1 1 2 6	1 4 2 10	1 7 2 14	1
2	0 2 12	3 2 16	6 2 20	9 2 24	0 12 3 0	0 15 3 4	0 18 3 8	1 1 3 12	1 4 3 16	1 7 3 20	2
3	0 3 18	3 3 22	6 3 26	10 0 2	0 13 0 6	0 16 0 10	0 19 0 14	1 2 0 18	1 5 0 22	1 8 0 26	3
4	1 0 24	4 1 0	7 1 4	10 1 8	0 13 1 12	0 16 1 16	0 19 1 20	1 2 1 24	1 5 2 0	1 8 2 4	4
5	1 2 2	4 2 6	7 2 10	10 2 14	0 13 2 18	0 16 2 22	0 19 2 26	1 2 3 2	1 5 3 6	1 8 3 10	5
6	1 3 8	4 3 12	7 3 16	10 3 20	0 13 3 24	0 17 0 0	1 0 0 4	1 3 0 8	1 6 0 12	1 9 0 16	6
7	2 0 14	5 0 18	8 0 22	11 0 26	0 14 1 2	0 17 1 6	1 0 1 10	1 3 1 14	1 6 1 18	1 9 1 22	7
8	2 1 20	5 1 24	8 2 0	11 2 4	0 14 2 8	0 17 2 12	1 0 2 16	1 3 2 20	1 6 2 24	1 9 3 0	8
9	2 2 26	5 3 2	8 3 6	11 3 10	0 14 3 14	0 17 3 18	1 0 3 22	1 3 3 26	1 7 0 2	1 10 0 6	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs. 2·83	lbs. 5·66	lbs. 8·5	lbs. 11·33	lbs. 14·17	lbs. 17·0	lbs. 19·83	lbs. 22·67	lbs. 25·5	lbs. 28·34	lbs. 31·17	lbs. 34	Weight.

Weights of Lengths of Rolled Steel Sections.

Beam 8 in. × 6 in. × 34 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	1 10 1 12	3 0 2 24	4 11 0 8	6 1 1 20	7 11 3 4	9 2 0 16	10 12 2 0	12 2 3 12	13 13 0 24	0
10	0 3 0 4	1 13 1 16	3 3 3 0	4 14 0 12	6 4 1 24	7 14 3 8	9 5 0 20	10 15 2 4	12 5 3 16	13 16 1 0	10
20	0 6 0 8	1 16 1 20	3 6 3 4	4 17 0 16	6 7 2 0	7 17 3 12	9 8 0 24	10 18 2 8	12 8 3 20	13 19 1 4	20
30	0 9 0 12	1 19 1 24	3 9 3 8	5 0 0 20	6 10 2 4	8 0 3 16	9 11 1 0	11 1 2 12	12 11 3 24	14 2 1 8	30
40	0 12 0 16	2 2 2 0	3 12 3 12	5 3 0 24	6 13 2 8	8 3 3 20	9 14 1 4	11 4 2 16	12 15 0 0	14 5 1 12	40
50	0 15 0 20	2 5 2 4	3 15 3 16	5 6 1 0	6 16 2 12	8 6 3 24	9 17 1 8	11 7 2 20	12 18 0 4	14 8 1 16	50
60	0 18 0 24	2 8 2 8	3 18 3 20	5 9 1 4	6 19 2 16	8 10 0 0	10 0 1 12	11 10 2 24	13 1 0 8	14 11 1 20	60
70	1 1 1 0	2 11 2 12	4 1 3 24	5 12 1 8	7 2 2 20	8 13 0 4	10 3 1 16	11 13 3 0	13 4 0 12	14 14 1 24	70
80	1 4 1 4	2 14 2 16	4 5 0 0	5 15 1 12	7 5 2 24	8 16 0 8	10 6 1 20	11 16 3 4	13 7 0 16	14 17 2 0	80
90	1 7 1 8	2 17 2 20	4 8 0 4	5 18 1 16	7 8 3 0	8 19 0 12	10 9 1 24	11 19 3 8	13 10 0 20	15 0 2 4	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	15 3 2 8	30 7 0 16	45 10 2 24	60 14 1 4	75 17 3 12	91 1 1 20	106 5 0 0	121 8 2 8	136 12 0 16	151 15 2 24	

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handled. After this it remains for the shale-oil to be refined before the maximum value is obtainable.

In conclusion, therefore, it is evident that we have material in abundance which is capable of furnishing the oil that we need for the future operation of our motors, but before this raw material can be used it must be dug from the earth, then it must be treated in elaborate and expensive apparatus which is as yet unperfected. The successful oil-shale plant will necessarily be one capable of treating at least 1,000 tons of shale per day, for it will be possible under efficient and economical management to realise only a small profit from each ton of rock handled. Before the oil-shale industry is on a profit-paying basis much time and money are bound to be spent, and a great many people who have been led to believe that the oil-shale industry will rival the gusher oil well as a money maker will be disappointed. However, I can see no other way but that eventually the oil-shale of Colorado, Utah, Wyoming, and perhaps some of the other States, will be made to produce oil, fertiliser, and profits in large quantity.

(*Concluded.*)

FOUNDATIONS.

By W. H. Latham.

(*Continued from page 431.*)

Materials Employed.

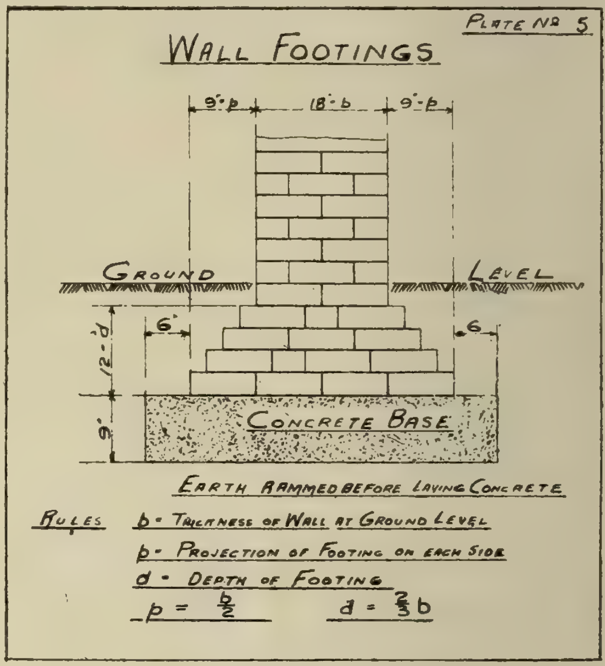
Materials used in foundations include timber as piling or sleepers, cast-iron and steel for cylinders, caissons and piling; but the most widely used materials are brickwork, stone, and concrete.

The determining factor in the choice among these is usually the pressure on the upper face, and the safe loads are given in Table No. V.

Table No. 5.

Safe loads on Foundation Materials.	Tons per sq. in.	Authority.
Stockbricks in grey lime mortar	4	W. H. Adams.
Stockbricks in Lids lime mortar	5	Do.
Cement. Sand. Broken stone.		
Concrete 1 1½ 3 at 60 days ..	14	A. N. Talbot and others.
1 2 4 Do. ..	10	Do.
1 3 6 Do. ..	6	Do.
1 2 4 (New Clyde Bridge) ...	7	Matheson.
Red brickwork in cement (New Clyde Bridge)	10	Do.
Blue brickwork in cement (New Clyde Bridge)	15	Do.
Concrete 1-2-4 L.C.C. Specification ...	11½	
Portland cement and sand mortar 1-3	15	H. G. Barnbee.
Freestone squared rubble in cement .	8	Matheson.
Freestone Ashlar masonry cement ..	15	Do.
Granite Ashlar masonry cement	25	Do.
Freestone Ashlar Bearing Blocks ...	12	Do.
Granolithic Ashlar Bearing Blocks...	12	Do.
Granite Ashlar Bearing Blocks	20	Do.
Wirksworth Limestone..............	18	
Quartzite	22	
Aberdeen Grey Granite	35	

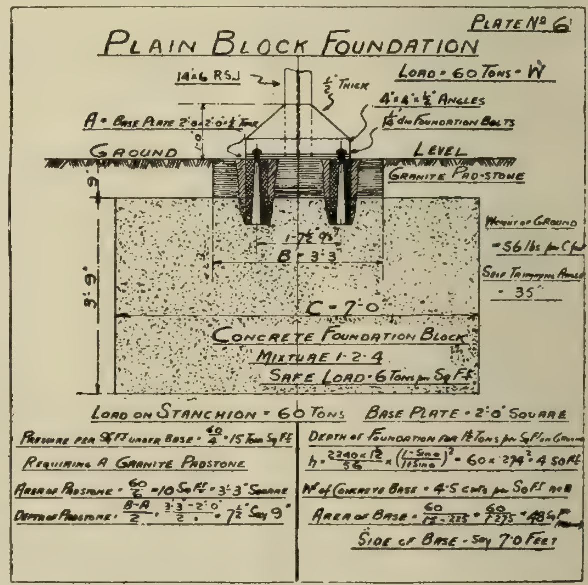
For pressures exceeding these values a C.I. bearing block may be used. The advantages of concrete are cheapness, soundness and durability, and to-day this material has practically swept all others out of the field. Brickwork can be constructed more rapidly, and with cement mortar is nearly as strong as concrete; also



Foundations.—Fig. 5.

considerable loads can be applied immediately after erection without risk of failure, and no shuttering or moulding timber is needed. The use of stone is confined to quarry districts, where it is cheap, and special positions where heavy surface pressures have to be carried.

The concrete for foundations is usually a 1-2-4 mixture, that is, one volume of cement, two volumes of sand, and



Foundations.—Fig. 6.

four volumes of aggregate, which is usually gravel or broken stone.

For plain foundations the aggregate should be broken to pass a 2½ in. ring, but where joists or reinforcing

materials are used the aggregate should pass a $\frac{3}{4}$ in. mesh. The water required is about equal to the volume of cement. It should be noted that the volume of concrete obtained is not equal to the sum of the volumes of the components. The sand goes into the spaces among the aggregate, and the cement into the spaces between the sand grains.

The actual bulk of concrete obtained runs from 70 to 80 per cent of the volumes of the materials, excluding that of the water. A very useful book on cement and concrete is issued by the Associated Portland Cement Manufacturers, Lloyd's Avenue, London, E.C.

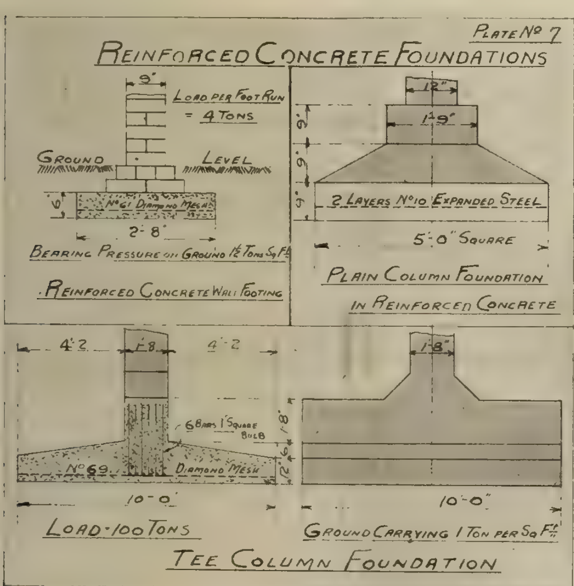
Classification of Foundations.

A provisional classification of foundations may be made as follows :—

(1) Plain blocks in brickwork, masonry or concrete.
(2) Reinforced concrete blocks or rafts.
(3) Grillages.
(4) Cylinders Caissons or Wells.
(5) Piled work.

Plain Block.

The plain block foundation is the commonest, and is easily made. For brickwork or masonry the foundation is spread out from the ground level to the required size in regular steps, which are called "Footings," as shown on Fig 5. For brick walls the footings are carried out to twice the width of the wall at the ground level, and are made two-thirds that width in depth. A concrete base 9 in. thick and projecting 6 in. each

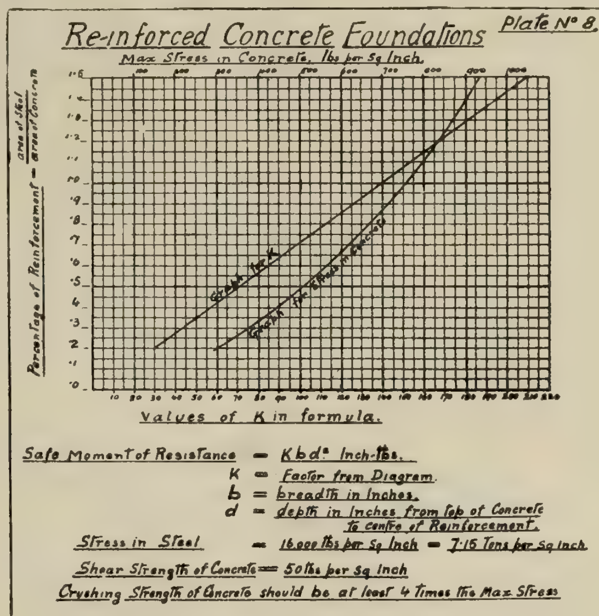


Foundations.—Fig. 7.

side of the footings, is usually laid under the brickwork. If it is not used the bottom course should be doubled. In soft strata the bottom of the excavation should be well rammed before putting in the foundation. For a plain concrete base, as in Fig. 6, the depth should be not less than the projection beyond the superstructure ; for long walls it should be one and a half times the projection.

Reinforced Concrete.

Where heavy loads are carried on soft material the foundation must be spread out to give the necessary area, and this leads to a greater depth of concrete. Good concrete weighs $1\frac{1}{4}$ cwt. per cubic foot, so that a block 8 ft. deep puts half a ton per square foot on the earth, which is a serious reduction of carrying capacity on soft soils. In such cases a reinforced concrete block or raft



Foundations.—Fig. 8.

may be used as in Fig. 7, the depth being only a fraction of that needed by the plain block. The ratio of depth to projection given above for plain concrete is necessary because of the relatively low tensile and shearing strengths.

For a 1-2-4 mixture the safe stresses are :—

Compression	=	600 lbs. per square inch
Tension	=	50 lbs. per square inch.
Shear	=	40 lbs. per square inch.

In the reinforced foundation the tensile, and sometimes the shear stresses, are taken by steel bars or wire embedded in the concrete. Under these conditions, the size of base having been determined to give a suitable bearing pressure on the earth and stability against side thrust, the depth and amount of reinforcement may be determined as follows :—

Let Pi = max. pressure on leeward side under base in lbs. per sq. ft. space 1 = projection of base in feet.

Then the bending moment over a strip 1 ft. wide will be $M = 6\,p\,1^2$ in. lbs.

The moment of resistance of a reinforced concrete slab can be expressed as $Z = k\,b\,d^2$ where b and d are in inches and k is a coefficient depending on the per cent of steel and the maximum stress in the concrete, as shown on the diagram No. VIII.

Choosing a suitable value for k we have $6\,P,\ 1^2 = b\,k\,d$

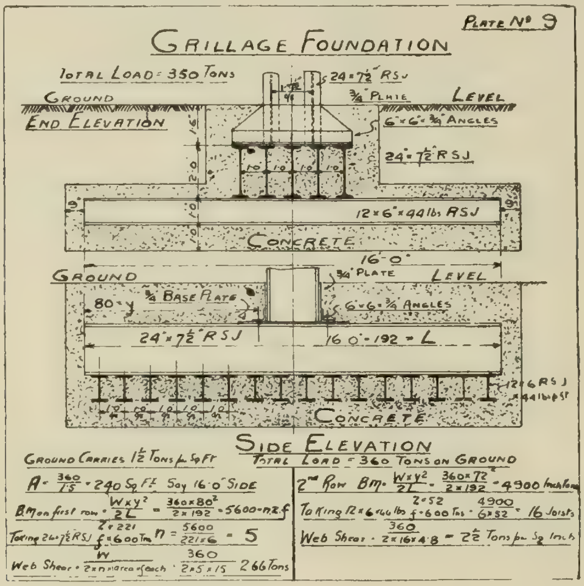
2, and since $b = 12$ in. $Pi\ 1^2 = 2\,k\,d^2$, and $d = \frac{Pi\ 1^2}{2k}$.

The value of d should be checked over to see that the shear does not exceed 40 lbs. per square inch, and, if necessary, shear bracing may be put in or the foundation thickened up to take the shear, In isolated foundations

two sets of bars should be put in at right angles to each other ; each strong enough to take the bending stresses in its direction. The earth should be rammed and a bed of concrete at least 3 in. thick put down and screeded level ; the reinforcement is then laid on this ; mould put round and filled up with concrete to the proper depth.

Grillage Foundation.

Another method is to use R.S.J. embedded in concrete to take the bending moments. In this case the joists are arranged to take the whole load, the concrete being



Foundations.—Fig. 9.

only a protective casing. For a wall a single tier of joists may be used ; for a stanchion, as in Fig. 9, a double or treble layer may be used. The calculation are given on the figure.

Like the reinforced concrete, it allows a shallower foundation to be used, reducing the cost of excavations and concrete. Where a gravel or conglomerate bed overlies a sand or clay the deep excavation might be impracticable and the grillage may be the only solution.

(To be continued.)

ECONOMIES IN THE GENERATION AND USE OF STEAM.

By Sidney F. Walker, R.N., M.I.E.E., M.I.M.E.

(Continued from page 430.)

The Bonecourt Boiler.

Readers will be familiar with the work of Professor Bone and the boiler that has been designed to work on the principle that he has advocated. It will be remembered that in his boiler there are a large number of tubes filled with a porous, refractory substance that can be raised to incandescence. The water occupies the spaces between the tubes. The boiler resembles the marine boiler and the dry-back boiler, without the furnaces and without the smokeboxes. Gases at a high temperature formed by the combustion of one of the gases that have been referred to above are forced through the tubes under pressure, the result being that the porous material is raised to a very high temperature, 3,000 deg. Fah., and upwards. A temperature of nearly 3,500 deg. Fah. has been claimed by Professor Bone, the gases being cooled down in passing through the boiler and through a feed-water heater to a temperature of 175 deg. Fah. No comment is needed upon the very high efficiency of the arrangement. The boiler has been employed with exhaust gases from gas engines and with live gas direct from a furnace.

It appears to the writer that Professor Bone has hit upon a method of carrying out the idea suggested above of very thin streams of gas flowing over surfaces against which the water to be heated impinges. It will be remembered that one principal cause of the low efficiency of some boilers is that owing to the low thermal conductivity of all gases only a very small portion of the gas takes any appreciable part in heating the water. In the Bonecourt boiler the porous material breaks up the volume of gas into a number of very minute streams. The individual streams must be much smaller than anything that could possibly be hoped for in the arrangement of diaphragms outlined above; consequently every fraction of the gas is doing useful work by delivering up all its heat to the refractory material. The refractory material not only breaks up the gas into minute streams, but it also stores the heat delivered by the gas, its own temperature being raised in the process, and the heat being delivered in due course to the water, or steam, on the other side of the tubes. The capacity of the refractory material to accept all the heat delivered to it by the gas, and to have its own temperature raised to the figures mentioned above, also goes to raise the efficiency of the whole arrangement. It will be remembered that the efficiency of the boiler depends very largely upon the continuous transmission of heat to the water or the steam, and this is ensured by the presence of the stored heat in the refactory material in the tubes. It will also be remembered that the efficiency of the boiler as a whole, and also of the boiler and steam engine or turbine, is increased by any increase of temperature at the end where the heat is delivered to the water.

The writer is aware that up to the present pressures of only 100 lbs. per square inch have been obtained with the Bonecourt boiler, but he feels sure that later developments will enable higher pressures to be carried. The arrangement of the Bonecourt boiler, if it can be adapted to the pressures that are in sight, 350 lbs. and upwards, appears to him to be as near the ideal boiler as it is possible to get. On the other hand, with the research that we are promised, it is quite on the cards that some even better arrangement will be devised. Once it is realised that gas can be economically used, and that what is required is the splitting up of the volumes of hot gas and the volumes of water or steam into very small particles, the probability is that invention will be prompt to meet the requirements of the steam engineer.

The Question of Clean Gas.

In the discussion that has recently taken place upon the firing of boilers by gas, the cleaning of the gas has naturally bulked very largely. With coke-oven gas and with producer gas the question should hardly arise, as it is part of the arrangement with both of those to obtain the by-products, and cleaning

the gas is part of the process of attaining the by-products. In both coke-oven and producer gas there is a certain quantity of tar and ammonia mixed with the gas, and if that is allowed to find its way into the engine cylinders, there is constant trouble in running the engines; valves stick, and other troubles arise. On the other hand, both the tar and the ammonia when further worked up yield valuable substances that add considerably to the credit side of the balance sheet. The ammonia, when converted into sulphate, commands a fairly high price. There is an increasing demand for it as manure, and if the policy of growing a large proportion of our own cereals is followed, the demand for it should go on increasing for a long time to come, and the price obtained for it should increase. The tar also, under modern arrangements, yields very valuable substances, benzole, the materials from which aniline dyes are made, and others. The writer is aware that some coke-oven gas is not cleaned, but in his view the need for economy in every product will be so great during the coming years while we are reducing our enormous war debt that everyone will be obliged to practice economy, and consequently all coke-oven gas and all producer gas will be deprived of every substance that can be sold or used, and will be presented clean to the boiler engineer.

Blast-furnace gas is, of course, different. There is no reason to suppose that it contains any ammonia, such as all coals and many of the waste products that are worked up in gas producer do. There have been reports in the daily press and in some of the technical journals that potash is obtainable from some blast-furnace gas. If so, it will be well worth the cost of treating the gas to recover the potash, if it is present in any appreciable quantities. Sulphate of potash and other salts of potash have also been introduced during recent years as manures for the land, and have been of great value. It is the common practice now, with advanced agriculturists, market gardeners, fruit growers, and others, to dig in a certain quantity of the salts of potash and lime into the soil during the autumn. The autumn, winter, and spring rains wash them into the soil and distribute them, the result being a practical renewing of the fruitful qualities of the soil. It will be understood that when crops are taken from the soil, whether they are cereals, vegetables, or fruits, certain substances that are used in building up the different crops are taken from the soil, and unless these are renewed from time to time the soil becomes poor and the yield heavily decreases. The old method of manuring with farmyard and stable manure has been found to be very wasteful in labour and material. A large quantity of stable manure has been found to contain only as much real nutriment for the soil, the substances the crops are calling for, as a very small quantity of what it is the fashion to call artificial manures—the salts of potash, ammonia, lime, etc. Even farmers are beginning to appreciate the advantages of using the salts in question in place of their manure.

If, then, a by-product or by-products can be obtained from blast-furnace gas, the problem of cleaning will be solved. The writer suggests that it will be well worth the while of chemists to thoroughly test every kind of the gas, and the dust that it brings with it to see whether there is not some substance contained in either of them that is worth recovering.

The principal trouble with blast-furnace gas is, of course, the dust that it carries from the furnace. The writer suggests again that blast-furnace managers may be able to amend their methods so that the gas comes away with a smaller quantity of dust than is now the rule. It will be remembered that the gas is the result of the smelting of the ore at the bottom of the furnace, the formation there of carbonic acid gas, and the passage of this gas, together with the other gases contained in the blast, through the ore, limestone, and coke in the upper part of the furnace. As is well known, the carbonic acid gas takes up another atom of carbon from the incandescent coke through which it passes, forming carbonic oxide gas, and it is to the presence of this gas that the calorific value is largely due. Unfortunately, the current of gas passing through the loose mass of incandescent material carries with it minute particles of the different substances, and that is what forms the dust that is so troublesome.

It was pointed out in the discussion on the subject referred to above that the wet process of cleaning the gas was the most efficient, but it entailed the presence of a certain quantity of water vapour in the gas which lowered the efficiency of the boiler. The effect was the same as that of feeding wet coal into a boiler furnace. The water vapour had to be raised to the temperature of the hot gases formed by combustion at the expense of the heat they carried, and it might happen that the steam so formed was decomposed into its component gases, this meaning a further absorption of heat, and again at the expense of the heat available for raising steam.

A little consideration will show that it is by no means impracticable to deal with blast-furnace gas, supposing that it contains no by-products worth saving, without subjecting it to this drawback. It will be remembered that the gas comes through the "downcomer" at a temperature of approximately 800deg. Fah. If the gas were clean, and could be taken direct to the burners in the boiler furnace, there would be a considerable gain. Therefore, if blast-furnace managers are able to arrange that the gas comes through the "downcomer" free of dust, they will add considerably to its value. It should not be impossible to trap the dust as the gas leaves the blast furnace before it has lost its temperature. On the other hand, the presence of a good deal of the dust is due to the high temperature, the minute particles of the substances present in the blast furnace being at a high temperature, are more or less in the nature of gas.

If it is found impracticable to trap the dust without the gas losing its temperature, the writer suggests that it might be treated in the same manner as the tail end of the boiler flue gases are, and led through an economiser to heat the feed water for the boiler. The working of the economiser attached to a boiler would be very similar with blast-furnace gas to that which would rule with flue gas. Just as the minute particles of carbon carried by the boiler flue gas are deposited upon the outsides of the economiser tubes, so the dust from the blast-furnace gas should be deposited in the same way, and could be scraped off by the usual scrapers. There should be no difficulty in the matter of the temperature of the

blast-furnace gas even if it is much higher than the figure named. When the firms who make economisers were investigating the matter, they found that in quite a number of cases boiler flue gases reached the chimney at temperatures of 900 deg. and 1,000 deg. Fah. so that the blast-furnace as would not bring any fresh problem in that respect.

There is one point that should perhaps be mentioned. The development of the electric furnace may sweep the blast furnace out of existence, and with it the supply of blast-furnace gas, and also the demand for a large portion of the coke that is made, and with it the supply of a corresponding portion of coke-oven gas. The development is possible, but it will be probably a very long time. The vested interests of the blast furnaces and coke ovens will fight hard against extinction, and they will render the time required to do away with them considerable, and meanwhile their gases will be available. It is more than probable also that their methods will be improved by competition, and this will increase their life.

(To be continued).

JIGS, TOOLS, AND SPECIAL MACHINES, WITH THEIR RELATION TO THE PRODUCTION OF STANDARDISED PARTS.

By Herbert C. Armitage, of Birmingham, Associate Member.

(Continued from page 436.)

General Works Organisations.

The centralisation of work, with consequent grouping of similar machines, was considered to be the ideal engineering practice a few years ago, but the practice is now deservedly losing much of its favour, where the finished product contains a large number of detail parts. Its chief advantages can only be obtained by the formation of a centralised system of arranging the work on every machine independently of the various foremen. A large workshop should be an aggregation of small shops or sections, in the author's opinion, which can preferably be separated by some form of barrier, but it is essential they should be under a centralised progress system and centralised management. In this way, taking as an example a works producing petrol engines, there would be a crankshaft section, a cylinder section, a crank-case section, and each would have its own complete quota of necessary machine tools, and its own bonus on output. To start upon a new type of engine, under these conditions, would not be a great problem, as every part on a new design is more or less similar to its predecessors.

There is yet a very much wider field for the semi-specialised manufacturing machine tool. As an example, there is not a lathe for sale which it is not possible radically to alter and improve, which is designed solely for motor-car or aeroplane-engine crankshafts. It still seems necessary for every concern to design and build a large proportion of its own manufacturing machine tools to maintain its progress and commercial supremacy. The professional machine-tool maker can use very few specialised tools in his manufacturing, and a batch of 12 similar machines is as near as he usually gets to repetition work. It is, however, rather a hopeful sign that many machine-tool firms are now specialising in particular lines, and not making everything that offers itself to them, as in the past.

Degrees of Use of Special Tools.

It is a debatable point to know to what extent components should be "jigged and tooled" according to the quantity required "off." There are several firms in this country who lay out and manufacture a complete set of tools for so small a number of pieces as five. This is a small quantity, and depends upon the organisation and manufacturing methods employed by the concerns. In the author's opinion, it is more a question of time that should decide the matter—that is to say, if the component can be machined by special tools and unskilled labour in very much less time than with standard fixings, the special tools should certainly be made even if the total cost, including the tool making, becomes higher than the mathematically calculated saving. There will be other things to consider, for instance, the time occupied by the shop administration in rigging up temporary tools, the chances of error and scrap, or the possibility of a repeat order. Furthermore, the special tools themselves will have a certain plant value.

Formulæ of Output to Pay for Tools.

Some formulæ, and the mode of procedure, in connection with the foregoing remarks, may be of interest, and are given below:—

(1) Lay out operations for the piece, using existing tools.

(2) Lay out operations for the piece, using special tools.

(3) Ascertain definitely what is the total number of parts required.

(4) Estimate the cost of machining, using existing tools.

(5) Estimate the cost of the special tools required.

(6) Estimate the cost of machining with the special tools. In doing this, points peculiar to the establishment should be observed, and the various fixed charges put on each. This is important, as the tool-room charge and the manufacturing working cost load is usually different. It should also be borne in mind that with special tools, cheaper labour can be used.

If E equals cost of the component, using existing tackle.

If S equals cost of the component, using special tools.

If T equals cost of the special tools.

If N equals number of parts to be made.

Then, excluding items of expediency, the least number of components required to cover the cost of the tools will be given by:—

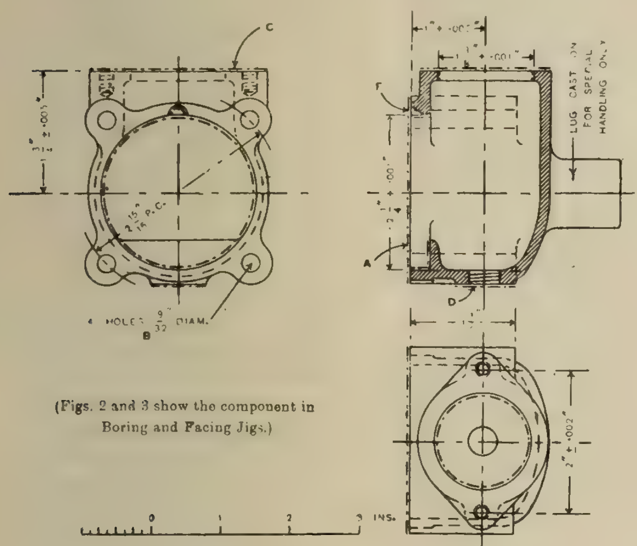
$$N = \frac{19\ T}{20\ (E - S)}$$

The formula allows for the plant or metal value of the tools (assuming they are never used again for the component), as 5 per cent of the original cost, which is perhaps rather high.

Similarly, the maximum that may be spent on special tools for "N" components is given by:—

$$T = \frac{20\ N\,(E - S)}{19}$$

To give an idea how the formulæ work out, they have been applied to a small aero-engine component, Fig. 1. There is comparatively little machining upon it, and assuming that the casting is to be tooled without special tools, the operations will



(Figs. 2 and 3 show the component in Boring and Facing Jigs.)

Jigs, Tools, etc. Fig. 1.

be as in Table 1. To grip the work in a chuck, it will be necessary to cast a small spigot on it for holding purposes.

TABLE 1.

Operation.	Time allowed	Rate. Per hour s. d.	Cost. s. d.
1. Preliminary marking off ..	10 min.	1 6	0 3
2. Bore and face (hold in chuck by special spigot) (A)	30 min.	1 2	0 7
3 Mark out and drill four holes in front (B)	1 h.	1 2	1 2
4. Set up on an angle plate to bore and face end (C)...	2 h.	1 2	2 4
5 Mark out for drilling $\frac{3}{1}$ in. holes on face (C)	30 min.	1 6	0 9
6. Drill and tap $\frac{3}{16}$ in. holes on face (C)	30 min.	1 2	0 7
7. Drill face and tap bottom hole (D)	20 min.	1 6	0 6
8. Cut off turning spigot	17 min.	1 2	0 4
9. Hand finish where spigot is cut off	10 min.	1 0	0 2
10. File Notch (F)	20 min.	1 6	0 6
	5 h. 47 min.		7 2

It is to be noted that the slowest operation is that of setting the angle plate to the correct dimension, 1 in. −'0.005 in., but if there were five or six pieces to run through consecutively, a considerable saving in time would result, as the machine could remain set up.

Employing jigs, but no special reamers or other tools, the job would work out as in Table 2:—

TABLE 2.

Operation	Jigs and Gauges.	Cost. £ s.	Time and Rate	Cost of Labour. pence.
1. Set in jig ..	Jig.	10 0	10 min. at 8d.	1·33
Bore & face at (A)......	Combined depth and plug gauge.	0 15		
2. Set in Jig ..	Jig.	8 10	10 min. at 8d.	1·33
Bore & face at (C). Revolve jig & face at (D)	Plug gauge.	0 10		
3 Drill all holes. Tap holes where required	Drill jig.	12 0	15 min. at 6d.	1·5
4. Mill slot (F)	Mill jig.	4 0	2 min. at 6d.	0·2.
Total cost of tools . .		35 15	Machining cost	4·36

From these two sets of figures we get:—

Cost of component for machining, using existing tackle .... E = 7s. 2d.
Cost of component for machining, using special tools and gauges........... S = 4·36d.
Cost of special tools .... T = £35 15s. 0d.

The number of components to cover the cost of tools is equal to:—

$$\frac{19 \times £35\ 15s.\ 0d.}{20\,(81{\cdot}64)} = 100.$$

The usual practice in most of the English automobile works at present is to make special tools for quantities of at least 25 components, as the advantages in practice outweigh the difference in cost.

(To be continued.)

GRAPHICAL AIDS IN MANAGEMENT.

By George Harrison.

(Continued from page 434.)

Sales and Publicity Department.

The sales department can also find many uses for graphical methods. It can, for instance, record the weekly or monthly sales per branch or traveller, by the means of curves of the ordinary variety, adding on the same record a curve showing the value of quotations sent out each month in each of the branch areas, thus making a valuable guide to and check upon the activities of the branches.

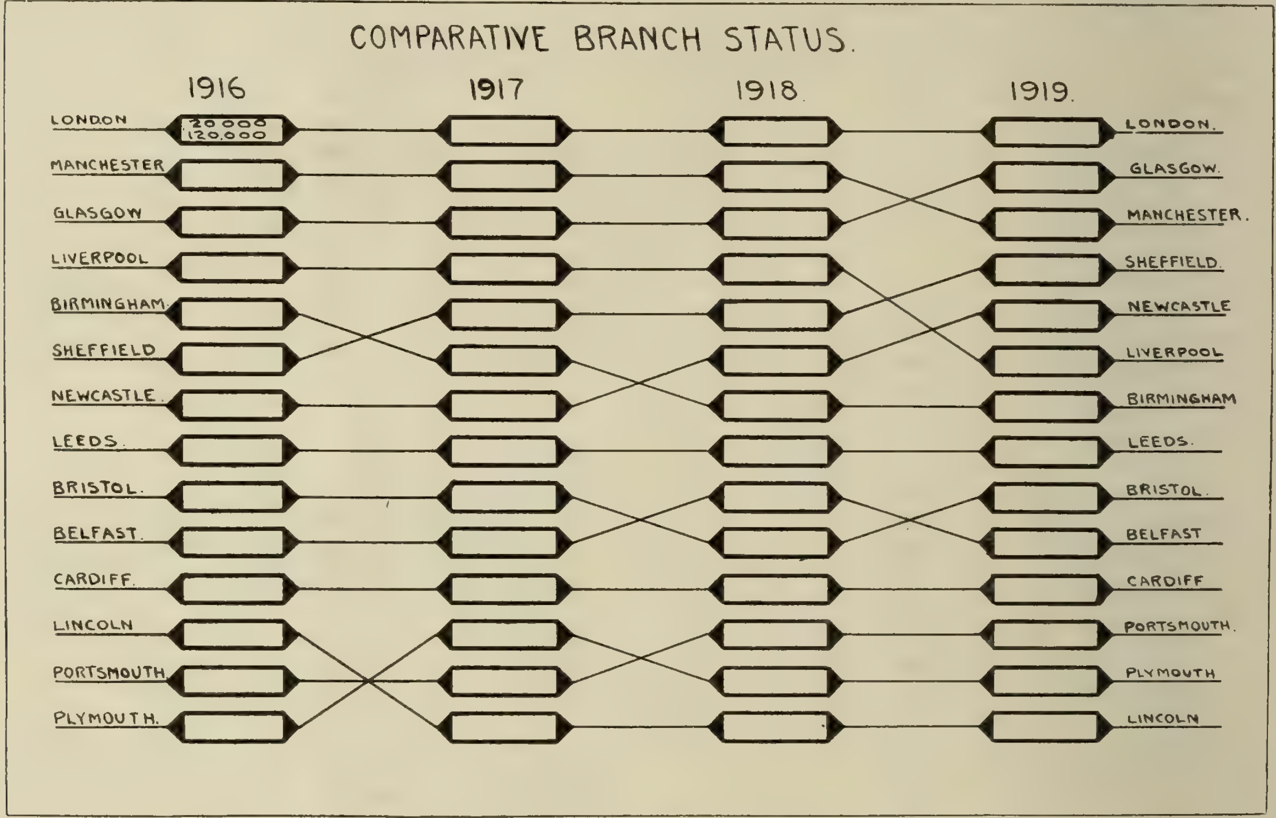
It is quite possible to standardise one or two varieties of ruled sheets or cards that are suitable for the various departmental requirements in a works, so that they can be filed either in loose-leaf books or in card index cabinets of standard sizes.

Fig. 4 shows a chart which indicates the relative efficiency of each sales branch of a business, through a series of years, not only for the information of the sales manager, but also as an incentive to the various branch managers. Each block may be filled in with a fraction representing the value of sales over the value of quotations, or any other useful information.

Another graphical aid that can be used with advantage in this department is the organisation of travellers' rounds by means of maps. We are all too familiar with the war maps, with their pins having red thread stretched between them indicating the position of the fighting forces. This method can be turned to the more peaceful use indicated above, with advantage to the firm and traveller, for the time taken in the office would be easily saved by the prevention of doublng back and overlapping that is quite likely to occur with more haphazard methods.

On the publicity side of this department business curves can be used to much effect, not only in advertising but also in cataloguing, where for instance the limiting pulley or pinion sizes for a range of machines manufactured by the company can best be shown by the aid of curves.

To the salesman, also, curves and charts are excellent aids in his interviews with prospective customers. The Admiralty indeed last year used curves to illustrate the sinking and new construction of shipping for the information of the general public; an admirable example, which deserves to be copied to a greater extent that it evidently is at present.



Graphical Aids in Management.—Fig. 4.

DESCRIPTION OF MACHINE } TYPE H84 D.C MOTOR

WORKS ORDER Nº 7954.

Nº OF MACHINES 50.

MATERIAL LIST LINE Nº	DRAWING AND PART NUMBER	PART	MAT'L	ORDER NUMBER AND DATE	FIRM.	TOTAL QUANTITY ORDERED	TOTAL WG'T LBS	DELIVERY DATE	BLACK LINE INDICATES MATERIAL ORDERED. RED LINE INDICATES MATERIAL RECEIVED GREEN LINE INDICATES SURPLUS MATERIAL.	EACH SQUARE =
3	15565-1	MAGNET CASE	C.St.	M612/5-1-19	A.B.&Co.	50	-	15-2-19		2
4	15565-2	POLE STAMPING.	Sh. I	M613/ "	C.D.&Co.	13000	3200	10-2-19		500
8	-	FIELD WIRE 24 E....	Cu.	M616/ "	E.F. LTD	-	1500	15-1-19		60 lbs
12	–	ARM. " 26 d.c.c.	Cu.	M617/ "	"	–	1000	"		50 "
26	15566-5	COMM BUSH	M.C.I.	M618/ "	G.H.&Co	52		15-2-19		2

Graphical Aids in Management.—Fig. 5.

Purchase Department.

Probably the purchase department was the first department outside the designers to introduce curves

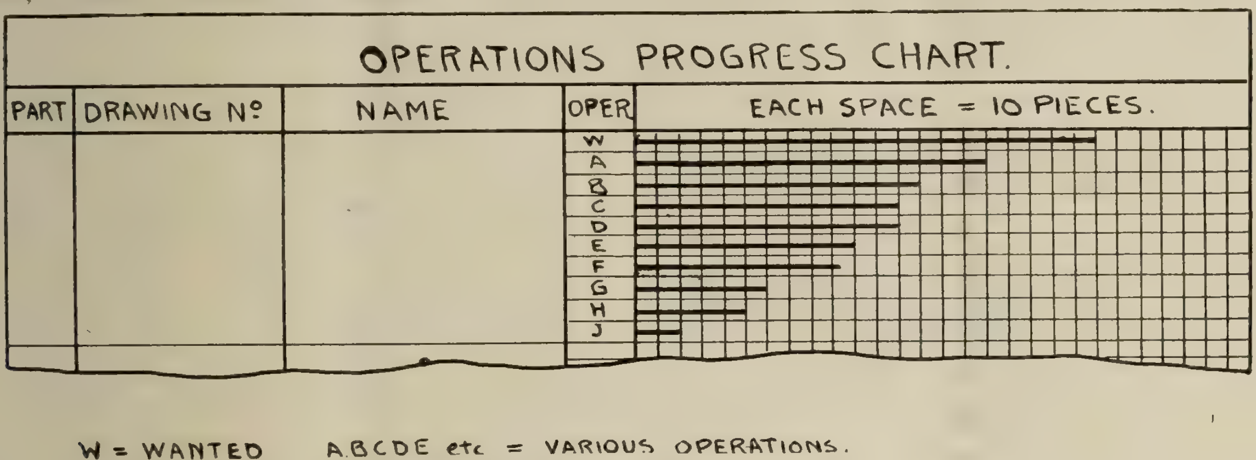
into use in the shape of material price curves so familiar to us in the excellent reproductions found in the technical journals. Without them, it is impossible for the buyer to gauge the markets and purchase efficiently.

Fig. 5 shows the application of the so-called strip chart, to record the amount of material in hand at any time for a given works order. It is, I think, self explanatory, and shows one of the many methods of applying the strip chart, which is probably the simplest and most useful graphical method for the departmental manager.

Progress and Planning Department.

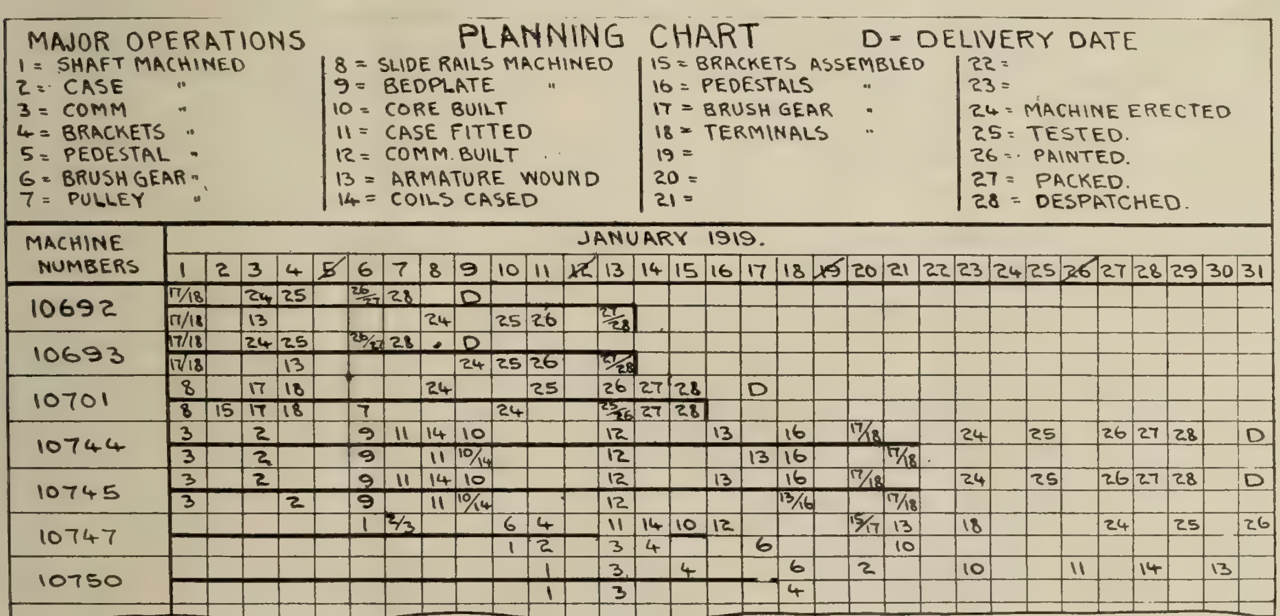
In progressing and planning, it is necessary to know the capacity of the machine tools, and this is most accessible when charted. Idle time should also be recorded, for without some such graphical record it is extremely difficult to plan production with any approach to accuracy.

Where a good deal of repetition work is done, the operations progress chart, see Fig. 6, is helpful. It is the work of Mr. Knoeppel, one of America's efficiency engineers. It is simple and visualises rapidly the progress of the work.



Graphical Aids in Management.—Fig. 6.

Probably the most difficult business to plan and progress work in is the jobbing shop, where all types and sizes of machines are built to special orders, usually singly and rarely in batches of more than 6 or 12. It is, of course, impossible to plan so accurately as in a repetition workshop, but some method must be adopted if the work is to be despatched in accordance with the delivery date given. Fig. 7 illustrates a works programme, suitable for such a business. Only the major operations are given, and on any given day the position of the work can be noted. The estimated operations to be completed on the given date are to be found above the line, and the actual operations completed below the line. The actual operation figures should be marked in in red ink if behind the programme date, and in green if to time. As each operation is completed, the centre line should be superimposed by a heavy black line to avoid the necessity of referring back more than necessary.



Graphical Aids in Management.—Fig 7.

Other variations will occur to the reader, and if any part is to be taken from stock, the operation next to be performed, could have the affix "S" added to its number. Should the work be held up or delayed by the customer, a new delivery date should be fixed, and the job replanned.

Probably, however, the planning board will supersede such charts in planning and progressing, owing to its flexibility, and the extra amount of information that can be placed thereon.

(*To be continued.*)

Trade Items, Notes, &c.

A New Steamship Line.—The Swedish navigation companies "A. Brostroem and Fils," the "Swedish East Asiatic Co.," the "Swedish American-Mexico Line," and the "Swedish American Line" have now amalgamated with a view to the exploitation of a new line between Sweden and the Orient. The new company will be entitled the "Svenska Oriebt Line," and its fleet will comprise eight vessels, ranging in tonnage from 2,000 to 3,800 tons. This line will serve more especially the ports of Pyraeus, Salonica, Constantinople and Odessa. The Swedish ports of departure will be Gothenburg, Stockholm, and Gelfe.

Standardisation of Chains (Roller Type up to 3 in. Pitch).—The Association of British Driving Chain Manufacturers, introduced in previous announcements, has effected the standardisation of roller chains and wheel-tooth widths for the above sizes as used for power transmission generally and particularly for cycles and motor cycles. The new Association standards are as follows :—

Association Chain No. Narrow	Association Chain No. Wide	Pitch.	Maximum Roller Diam.	Minimum Width between Plates. Narrow	Minimum Width between Plates. Wide	Min. Depth of Shroud below Roller Seating.	Maximum Tooth Width. Narrow	Maximum Tooth Width. Wide
		inch.	inch.	inch.	inch	inch.	inch.	inch.
3 N	3 W	3/8	·250	·155	·230	·070	·145	·220
Cycle Sizes		1/2	·305	·130	·192	·050	·120	·182
4 N	4 W	1/2	·335	·205	·305	·094	·195	·295
5 N	5 W	5/8	·400	·255	·380	·117	·245	·370
6 N	6 W	3/4	·475	·310	·460	·140	·295	·445

The above chains will be available early in December, 1919. Meanwhile any difficulty in changing over to the new standards will be obviated by the temporary adoption of the following tooth widths, which will accommodate existing sizes of chains as well as the new Association standards.

Type.	Pitch.	Maximum Roller Diam.	Nominal Width between Plates. Narrow	Nominal Width between Plates. Wide	Min. Depth of Shroud below Roller Seating.	Maximum Tooth Width. Narrow	Maximum Tooth Width. Wide
	inch	inch.	inch.	inch.	inch.	inch.	inch.
Cycle	1/2	·305	1/8	3/16	·050	·120	·182
Motor Cycle ...	1/2	·335	3/16	1/4	·094	·182	·245
do. ...	5/8	·400	1/4	3/8	·117	·245	·370
do. ...	3/4	·475	5/16	7/16	·140	·295	·435

Further announcements will be made giving details of standardisation of roller chains above 3/4 in. pitch, and of tooth forms. Eventually, when complete standardisation has been effected, full details will be published in pamphlet form, applications for which should be made to the secretary. Members of A.B.D.C.M. : Alfred Appleby Chain Co. Ltd., Tilton Road, Birmingham; Brampton Bros. Ltd., Oliver Street, Birmingham; "The Coventry" Chain Co. Ltd., Spon End Works, Coventry; Hans Renold Ltd., Burnage Works, Didsbury, Manchester.

One of the most interesting features of the forthcoming Shipping, Engineering, and Machinery Exhibition, to be held at Olympia, from September 25th till October 17th, will be the assemblage of water-softening and purifying plants at work. We are informed that such a comprehensive exhibit of pure-water producing plant has not previously been shown at any exhibition. The art of water treatment has made astonishing progress during the war, due largely to the urgent necessity which arose for completely effective treatment, not only for the water supplied to the armies on the various fronts, but also of the water used in the manufacture of many munitions of war, including explosives and many chemicals. The public will get a glimpse at Olympia of the methods adopted by the military and munitions authorities to secure pure water from supplies of every character, good and bad, for the all-important purposes of war. The lessons learned have been effectively turned to the service of the community in peace, and the water authorities of some of our principal cities now have plans in active preparation for the improvement of their water supplies by the methods which proved so successful under the severe conditions of the war.

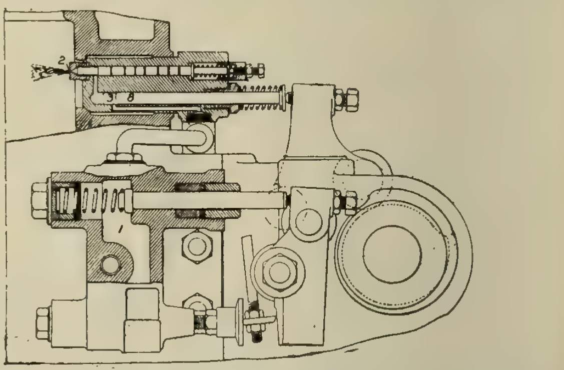
Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

INTERNAL-COMBUSTION ENGINES.

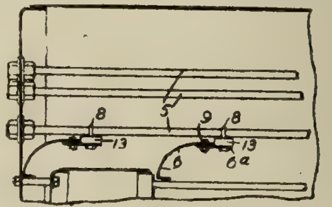
121,241.—H. N. Bickerton and A. B. Balmford, Wellington Works, Ashton-under-Lyne, Lancashire.—Mar. 21st, 1918.—The fuel



is supplied by a governor-controlled pump 1 to a chamber 3, whence it is expelled by a cam-actuated plunger 8 past the valve 2, which is opened by the pressure of the fuel.

STEAM BOILERS.

121,227.—Marine Appliances, Ltd., P. C. Ayers, and H. W. E. Josling, 39, Victoria Street, Westminster.—Feb. 15th, 1918.—A curved deflector plate for promoting the longitudinal circulation in a marine boiler is made of separable forward and rear

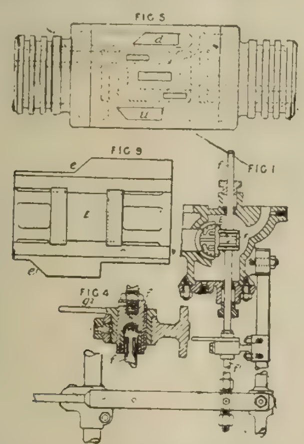


portions, the forward portions being suitably secured, say, to the stays, and the rear portions being so connected to the forward portions that they can readily be placed in position and removed. Sectional plates arranged above the combustion chamber as described in Specification 119,053 are built up of forward positions 6a secured to the stays 5 by U-shaped bolts 8, and rear portions 6 which are attached to the forward portions by eye-bolts 9. Pins pass through the holes in the heads of

adjacent bolts. Distance-pieces 13 are placed between the forward portions and the stays Finger-holes are formed on the rear portions to facilitate handling.

STEAM-PUMPS.

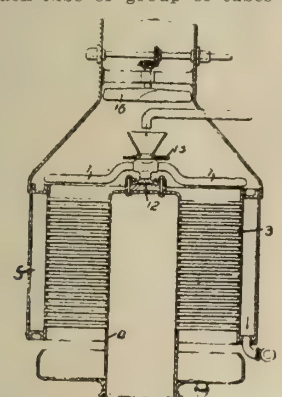
121,224.—J. TAYLOR, Soho Iron Works, Heywood, Lancashire.—Feb. 11th, 1918.—In a combined fluid-actuated and mechanical gear wherein an auxiliary valve E moves transversely to the main valve and acts as an expansion valve, the auxiliary valve E has bevelled edges *e*, *e*1 which control the cut-off of steam



passing through ports *d*, *d*, having inclined edges, in the main valve. The valve E is adjusted laterally by means of an eccentric F on the valve spindle *f*, *f*1, the two parts of which are connected by a ball-and-socket joint, Fig. 4, which permits the part *f* to be angularly adjusted by a handle *g*2 to vary the cut-off.

COOLERS; CONDENSERS.

121,313.—R. S. PORTHAM, 22, Billiter Street, London.—Nov. 13th, 1917.—An evaporative condenser or cooler consists of a stationary heat-exchanger comprising radial tubes 3 communicating with a distributing chamber 4 and a collecting chamber 5, together with a rotary liquid-supplying device 7 mounted above the tubes so as to drench each tube or group of tubes in succession. The



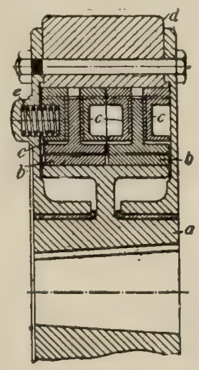
period between successive drenchings is sufficient to allow the liquid to evaporate. The device 7 consists of one or more arms fitted with nozzles, slots, etc., and rotated by a chain-wheel 13 or otherwise. Air, preheated if desired, is caused to flow over the tubes 3, for example, by means of a fan 16. When used as a steam condenser, the apparatus is fitted with a pump, ejector, etc., for maintaining a vacuum and extracting condensate. As applied to a locomotive, the condenser is cooled by a supply of water from the tender, the air being directed on to the tubes by a scoop.

CLUTCHES; BRAKES.

121,301.—H. FROOD, Sovereign Mills, Chapel-en-le-Frith, Derbyshire.—Sept. 8th, 1917.—Friction clutch linings and brake blocks and linings are made from one or more layers of woven or unwoven organic or inorganic fibrous materials or fibres, such as shredded, ground, or disintegrated asbestos, asbestos waste, kieselguhr, wool, hair, cotton, cork, or sawdust, or mixtures thereof, mixed or impregnated with resin formed by the condensation of formaldehyde or hexamethylenetetramine and phenol or its homologues. Fragments of metal, expanded metal, wires, or other reinforcements may be mixed with, or incorporated in, the material. The fibres, preferably asbestos, may be mixed with the resin in a finely-powdered state, moulded under heavy pressure and melted by heat, and afterwards stoved to give the required hardness; or the material may be impregnated at atmospheric or higher or lower pressures with a varnish made by dissolving the resin in alcohol, acetone, etc., and afterwards stoved. In order that the material may subsequently be softened by heat and bent to any required shape, the stoving temperature may be kept low. The powdered resin may be prepared by heating a mixture of formaldehyde, phenol, and a catalytic agent such as ammonium chloride or sodium sulphite or hydrate; or the resin may be formed in the body of the material by first mordanting the material with the catalytic agent, and then adding the other constituents. To render the finished product non-inflammable, the powdered resin may be saponified with an alkaline solution such as sodium or potassium hydrate, to which is added sodium silicate. To make the fireproofing body insoluble, lead nitrate, aluminium sulphate, or calcium chloride may be added to the solution or may be used to treat the impregnated material. A solution of aluminium sulphite is preferably added to the sodium hydrate solution or is applied to the impregnated material. In order to increase the heat conductivity of the material, the fibres or fibrous materials, preferably after mordanting, are treated with a concentrated solution of copper sulphate, aluminium sulphate, iron oxide, etc. Two or more layers of material may be united under pressure when in the saturated condition.

FLY-WHEELS; VIBRATION-DAMPERS.

121,228.—J. GARDNER, Barton Hall Engine Works, Patricroft, Lancashire.—Feb. 18th, 1918.—Relates to means for eliminating torsional vibration in the crank-shafts of high-speed reciprocating-engines of the kind described in Specification 21,139/10. Annular clutch members *b* of **T** or **L** shape are provided with

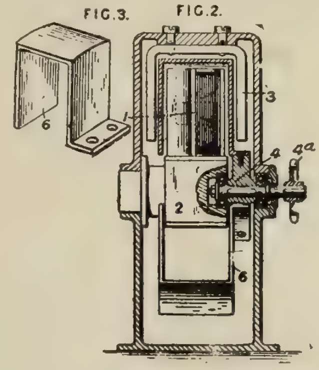


projections which enter keyways in the driving-elements *a*. Rings *c* keyed to the driven element *d* are arranged between and adjacent the flanges on the members *b*. The parts *b*, *c* are held in frictional contact by springs *e*.

DYNAMO-ELECTRIC MACHINES.

121,364.—J. F. POYNTER, Maxim Works, Canonbury Road, Highbury, Islington.—Dec. 21st, 1917.—A magneto or dynamo for ignition in multi-cylinder engines, etc., is provided with one or more stationary armatures 1 mounted upon a fixed hub 2, with

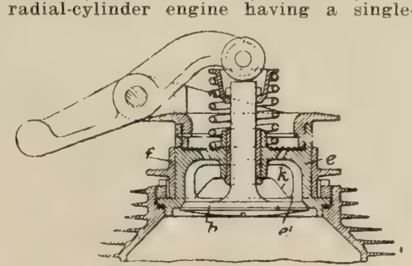
FIG.3. FIG.2.



one or more stationary magnets 3, and with a number of **U**-shaped plates 6 of magnetic material which are rotated in the spaces between the armatures and the magnets. The plates 6 are fixed to a central hub or spindle 4 which is driven from the engine by a chain and chain-wheel 4*a*. The plates 6 may be stationary and the armature and magnet rotated instead.

INTERNAL-COMBUSTION ENGINES.

121,366.—I. TURNER, Fir Tree House, Rochford, Essex.—Dec. 22nd, 1917.—In a radial-cylinder engine having a single-beat or lift

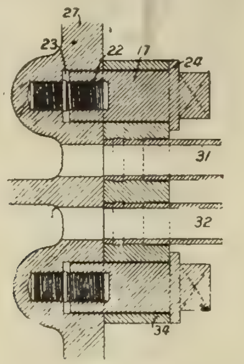


valve controlling inlet and exhaust the area of the air-admission passages is varied either automatically or mechanically in accordance with the speed. A valve *b* co-operates with a

removable seating e having a port e1 which registers with a port k in a sliding sleeve f surrounding the seating. The sleeve is held in its lowermost position by springs, and, in a rotating-cylinder engine it s moved outwards by centrifugal force upon an increase in speed. In a stationary-cylinder engine, the sleeve may be controlled positively. According to the Provisional Specification, the valve may control the supply of combustible mixture instead of air.

STEAM-SUPERHEATERS.

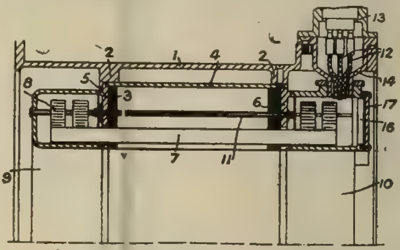
121,328.—J. G. ROBINSON, Mere Bank, Fairfield, Manchester.—Dec. 8th, 1917.—A superheater or like tube element 31, 32 is secured to the bottom or wall 27 of a header by screwed studs 22 so fixed in recesses 23 in the wall that they do not project beyond the face of the wall, and engaging with long box-nuts 17 extending through holes in a flange block 34 in which the



ends of the tube element are fixed. Flanges 24 on the outer ends of the nuts bear against the outer face of the flange block. A single screwed stud and nut situated between the two holes in which the ends of an element are fixed may be used in place of the two studs and nuts shown. The projecting screwed end of a bolt extending through the header from top to bottom or from side to side may be used in place of a screwed stud.

DYNAMO-ELECTRIC MACHINES.

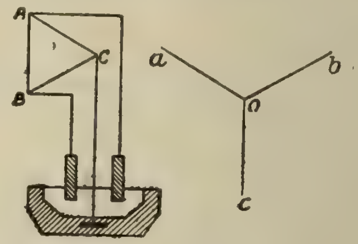
121,490.—J. S. HIGHFIELD, 19, Cottemore Gardens, Kensington, London.—Jan. 18th, 1917.—The winding end-connections 8 of a machine for working submerged in water or other liquid are enclosed in annular covers 9, 10 which are held in position by bolts 11 passing through the laminae 3 and end-plates 5, 6. The laminae 3 are cemented together under pressure and are contained within a gun-metal sleeve 4 resting upon projections 2 on the casing 1. The winding 7 is arranged in closed slots, the conductors being wrapped in layers of micanite with an outside covering of leatheroid. Conductors 12 from a coupling 13 pass through a gland 14 into the cover 10; The cover 10 has an opening 16 through which an insulating compound which sets as a solid is forced to fill all the spaces in the slots and in the covers 9, 10, the opening being afterwards closed by a plate 17.



The covers 9, 10 and the gland 14 are sweated to the stator framing. In place of the closed stator slots, a central lining of non-magnetic metal may be inserted within the core. The invention is applicable to the stators and rotors of both continuous-current and alternating-current machines.

ELECTRIC FURNACES.

121,563.—T. H. WATSON AND CO., Lancaster Street, Neepsend, H. A. GREAVES, 25, Raven Road, and H. ETCHELLS, 231, Oakbrook Road, all in Sheffield.—April 18th, 1918.—Two upper electrodes or groups, and a conductive hearth or third electrode, are connected to three delta-grouped transformer secondaries, the



transformer primaries being Y-connected to a three-phase supply circuit, and the ratios of transformation being such that, with a predetermined value of the hearth resistance, the supply circuit is symmetrically loaded for power and for power factor when the upper electrodes are conveying equal currents.

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